SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, APRIL 23, 1909

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

A PLEA FOR A WIDER AND BETTER EXTENSION OF THE KNOWLEDGE OF SANITARY SCIENCE[1]

SANITARY science is young, or, at least, that much may be said of the science as we know it to-day, and consequently I presume it is scarcely reasonable to expect the public at large to be very well posted as to its latest discoveries and improvements. But so much depends upon an intelligent cooperation on the part of the masses of the people in the matter of the proper application of sanitary principles that every effort should be made to hasten the day when sound doctrine shall underlie each act of the community that is made in the interest of public health.

In view of the great width of the field which suggests itself, some kind of reduction will be necessary for our present purpose. Therefore, may I ask your attention to two items with which I have had more or less to do, viz., "water" and "air"?

A great deal has been accomplished in recent years in the matter of educating the public in the proper care of domestic water supplies; but much misunderstanding yet remains for removal, and old-time traditions are with us still.

Did you ever hear that a horse will drink no water that is of inferior quality? Such a statement has been made to me many a time and has been insisted upon as a fact. The fairy tale is pretty widely distributed, especially in country districts, and it is received as true, although it needs but a

[1] Founder's Day address, given at Lafayette College October 21, 1908.

little observation of the habits of horses to establish its fallacy. Would you, as intelligent people, who have watched horses upon occasion, care to pin your faith upon the "horse-test" as indicating the purity of your household drinking water?

When I was a boy the belief existed that the presence of many flies tended towards a healthful summer, because they were held to be the means of removal of much waste material which would otherwise decay and taint the atmosphere. We now know that flies are a source of danger in that they do not wipe their feet before crawling over our food. In this connection note the disastrous typhoid fever outbreaks in our military camps during the Spanish war. Those epidemics were occasioned by the inoculation of food by flies; flies that visited the latrines first and the kitchens afterwards.

Returning now to the water question, the time-honored dictum that a clear, bright water is of necessity a wholesome one is also still widely trusted; but it reminds me of the ruling of a Mississippi chancellor in a case with which I was once connected. His honor threw all the expert testimony out of court with the remark that the ordinary citizen is able well enough to tell whether or not a given water is fit to drink. To illustrate how far the court fell short of the truth in this instance, let me say that not long ago the clear and bright effluent from the Saratoga sewage septic tank was placed in a show window in western New York alongside of an exhibit of the local water supply, to the apparent disadvantage of the latter. Poor as the town water was, it could scarcely have been fair to compare it with filtered sewage and yet his honor from Mississippi would have judged otherwise.

The "test of experience" is constantly appealed to in support of the alleged purity of some favorite water, and the plea that "my family has used the supply for half a century" is considered an argument beyond danger of refutation, it being overlooked that a family, or even several families, can not furnish a sufficient number of persons to make the "experience test" valuable; for, be it remembered, a water known to be dangerously polluted will not transmit disease to all, nor nearly all, of those who drink it. As a matter of fact, when one considers the question from a numerical standpoint, basing his investigation upon the population of a large community, the conclusion is forced upon him that the per capita danger from polluted water is really small. Thus, in a city of 100,000 inhabitants, which I have in mind, the high typhoid death rate, manifestly caused by bad water, was about 90 per year; which means that over 99,000 of the people did not have the disease at all.

Now how about this great majority of the citizens that escaped. They would not be likely to testify as to the dangers of the water supply. As you see, the risk is small and it takes a large community to make data about it valuable, but relatively small though it be, it nevertheless is a good investment for a city to avoid it, because human life has a money value and the town which cuts its typhoid rate in half by the erection of a filter plant receives very quick return for the funds expended.

Doubtless one reason why so many people deny the existence of danger lurking in some specific drinking water is because of the non-dramatic character of the attack.

Let us suppose that a city has a yearly typhoid death rate of 75, which means that 750 people per 100,000 inhabitants have the disease each year and that 75 of them die. The impression upon the community is not really felt except by those whose homes are invaded and the remainder of the population would be likely to resort to

the old story "we have used the water for years without harm, etc." What do you think would happen in such a city if some trolley road were so badly managed as to kill 75 people every year and injure 675 others? Do you fancy it would be long before there would be mob demonstration against such a road? Or again, suppose a foreign warship should drop shells into the streets of such a town, killing from one to two people weekly and wounding nine times as many; would the people who had been hit be likely to listen with patience to such of their neighbors as claimed that because they had not been struck they doubted if there were any war vessel in the river after all?

Let us glance for a moment at the question of atmospheric air.

We all breathe, but we have been doing it so long and for the most part so easily, that a great many of us forget that we do it at all. We also eat, but the occasions for eating produce an impression upon us. Moreover, we are to a large degree particular as to the quality of the things we eat. Fancy trying to induce your employees to accept improper and tainted food. Such an effort would very probably and properly breed a riot, and yet those same people will sleep in badly overcrowded rooms and will likely complain of drafts if the windows be open. Without food they could live a week and more, while with no air they could not survive five minutes, yet one hears but rarely any comment upon the quality of that necessity of life which is so vastly more important than food.

It doubtless would be a surprising statement to preach very widely, but the cold fact remains that bad air is responsible for more deaths than alcohol. Much as we deplore the evil effects of strong drink, its victims, both innocent and guilty, are few compared with those of the "great white plague." Are you aware that practically ten per cent. of all those who died in the state of New York during the past year died of consumption, a disease which is closely connected with polluted air? Please remember those figures, one in every ten.

This has been termed "the age of hygiene" and I think the expression a good one. Much hygienic advancement has been accomplished, but a great deal more remains to be secured. Perhaps as noteworthy an instance of improvement as can be quoted is the smaller amount of spitting one sees in the street cars. That is a most encouraging fact, but why should not ventilation of the cars be insisted upon also. Given a crowded car upon a misty evening in January when the workers are returning home with garments soiled and wet, if the ventilators be closed, as they commonly are, the air within is utterly unfit for breathing. If the two halves of the car roof were hinged upon a sort of ridge pole and occasionally thrown open for a short time, much improvement in the air would result and that too without complaint, because the public will accept a great inrush of cold air for a moment when they would object to a small stream of continuous flow.

As already said, much has been done, but the question is often asked, is there any substantial benefit to show for it? Are we really better off than our forefathers because we possess these so-called improvements?

There is but one answer to such a question and that is to ask the inquirer to consult the recorded death rates and to note that the total rate for London has fallen 75 per cent. in less than 300 years; that consumption in the English army has lessened since an increased air space has been provided in barracks; that small-pox is now practically unknown in the German army, because of compulsory vaccination; and that typhoid fever has been reduced in

some municipalities as much as 70 per cent. by the introduction of filtered water.

It being a fact beyond doubt that good sanitary knowledge is a real asset of a community, the question is in order, how are we to secure a better general understanding of sanitary principles? How are the people, particularly the poorer people, to be educated along such lines?

Of all members of a community, the physicians are the ones towards whom we most quickly look for instruction in matters sanitary. Their profession primarily, of course, deals with the combating of maladies already in evidence, but they have also an undoubted duty to perform in protecting men from disease as well as in curing them of it. That being granted, it is pertinent to inquire if the medical schools provide such instruction as will place their graduates in a position to properly meet their double responsibility. So far as I can discover, such a question must too often be answered in the negative. It is expected of a physician that he should speak ex-cathedra upon topics dealing with the protection of health, but, aside from some noteworthy exceptions, the average doctor has, through no fault of his own, been unprovided with very strong foundations in sanitary science.

Let us now look at another group of men with responsibilities.

Whenever human beings are gathered together in organized bodies, as during military service, those in control of them have the serious task of safeguarding their health and it goes without saying that such persons should be equal to performing the duties of their office. Of the amount of knowledge of a sanitary kind possessed by officers of the regular army I can not speak, although my belief is that those of the medical staff, at any rate, are well-posted men. All of us must surely allow no small measure of praise to the officers of the Japanese army in view of the excellent results secured by them during the Russian war.

What can be said, however, of the expert knowledge of our officers of militia? Simply nothing. As a class, they have no proper understanding of the sanitary needs of large groups of men and yet they have been and may be again suddenly called upon to command bodies of troops in the field. Of course the line officers have those of the medical staff to lean upon, but even so, an ignorant line commander can not be educated while on the march and he can readily place his men amid such unsanitary surroundings as will produce evils exceeding the power of his medical adviser to rectify. We all know the general method followed for the selection of militia officers and are aware that popularity, coupled with a knowledge of tactics, constitutes the total requirement for election. An examination has to be passed before a commission is secured, but in that examination the questions touching upon the sanitary care of troops are few indeed. Imagine a detachment of state soldiers suddenly deprived of meat food. Is it likely that many of their line officers would be capable of suggesting a vegetable high in nitrogen to replace it?

I contend that those who are responsible for the safety of enlisted men should be as well qualified to protect them from an invasion of disease as from the bullets of the enemy. For it has been well said that if we could eliminate disease from army life, then war would become an international pastime somewhat less dangerous per capita per hour for those engaged than college football. And further, not only should the officers be posted in matters sanitary, but the men themselves should receive some sort of instruction calculated to increase their safety, efficiency and comfort.

As akin to what we have said, our thoughts now turn to another group of responsible leaders who are placed in control of bodies of very ignorant laborers. I refer to our civil engineers. Such men have a double responsibility, for it is their duty not only to protect the health of their employees, but they are also bound to guard against the very real danger of contamination reaching some neighboring town's water supply by reason of the laborers camping upon the watershed. Many an epidemic has been traced to that source of pollution.

The curricula of our engineering schools are not destitute of instruction in sanitary science, but the time devoted to it is distinctly small.

Let us change the point of view for a moment and ask how much of this kind of information is possessed by our graduate trained nurses. With what confidence could you depend upon their knowledge of the dangers lurking in water or milk and the best way to guard against them? Are they as posted as they should be upon the longevity of the more common disease germs and do they know why corrosive sublimate is not uniformly a good disinfectant for tuberculosis sputum? The answer is evident, but the blame is not with them. It lies with those who mapped out their line of training.

As a final group for our consideration let us turn towards the children in our schools and the students in some of our non-technical colleges. Are they receiving the amount and particularly the kind of sanitary instruction fitted to their future needs as intelligent citizens? Please note that I dwell upon the quality as well as upon the quantity of teaching they receive. If they be taught to clean the outside only of the cup and the platter; if they be so misled as to confound a deodorizer with a disinfectant; if they be induced to believe that straining off that which is apparent to the eye will render a polluted water safely potable, then I claim that their little knowledge is a very dangerous thing and distinctly worse than none at all.

Of all the people in the nation, the ones from whom we expect the greatest returns for our efforts in sanitary instruction are those who are sufficiently young to approach the subject with no previous prejudices. One of England's greatest surgeons, now a few years dead, was a strong opponent of the germ theory of pus formation. He expressed himself as willing to dress his patients' wounds with such bacteria if he could but get enough of them for the purpose. Men so set in their ways do not easily respond to any form of conversion. It is with those who are now young that we must lodge our hope and it is among them that we should push our sanitary propaganda, but let us advance it evenly and by first-class instructors.

A word as to what I mean by such terms. An immense amount of effort has been expended in the cause of temperance and excellent results have been secured, but let me ask, has any similar crusade been pushed with equal vigor against the spread of other forms of intoxication; that, for instance, produced by the toxin of bacillus typhosus or the still more serious bacillus of tuberculosis? Have you any idea of the relative numbers of victims claimed by alcohol, typhoid fever and consumption each year? The effects of alcoholism are more dramatic and more disgusting and therefore more quickly command our attention, but as to the question of annual fatality and suffering produced, it is the least evil of the three.

	Deaths in State of New York, 1907
From alcoholism	1,023
From typhoid fever	1,688
From consumption	14,406

When a man drinks alcohol the object lesson for the onlooker comes speedily and it is easy for the reformer to enlist his sympathy in a temperance movement. But when one breathes in foul air loaded with the bacilli of tuberculosis no immediate results are observed and the opportunity does not present itself of closely connecting the inoculation with the subsequent development of the disease.

Please do not misunderstand me. I am very far indeed from wishing to in any way lessen the temperance movement, but I can not help feeling that the plan of campaign of that movement might very properly be studied, and possibly applied, for the arrest of the other two disorders mentioned above.[1]

Education is what is needed, not only for the purpose of coping with alcoholism, but with a view of attacking the other ills as well. You are aware, doubtless, that the temperance reformers have advanced their cause until it is a strong factor in matters political, and that they have secured the passage of laws ordering that public instruction be given as to the dangers incident to the use of alcohol. Have you ever heard of so considerable a movement being inaugurated to check the ravages of consumption or typhoid fever? Earnest efforts are now afoot to do something in that line and a good deal has been really accomplished, but those engaged in the work by no means exhibit the broad front and army-like march of the temperance organization. The people as a whole are not sufficiently educated as yet to appreciate the necessity of decided action and their sympathy with the needed reform is not awakened.

May I digress a moment and venture a word as to the wave of interest in the care and cure of consumption as we now see it in northern New York?

In the city from which I come we are plentifully supplied with committees of devoted men and women who contribute of their own means and ask pecuniary aid from others, giving meanwhile much of their time and energy for the purpose of relieving the wants and lessening the sufferings of their consumptive neighbors. The cause is such a noble one and the movement is so single-hearted that I feel badly indeed to predict its failure. Yet I believe that it must fail and for this reason. Successful handling of the consumptive poor must be the duty of public officers backed by the public purse. Funds raised by subscription and applied by voluntary workers can not grapple with the situation, because of the practically chronic character of the disease. If the community were invaded by cholera, yellow fever or the black death, and if the dead were being removed in furniture vans, as they were at Messina in 1887, then the "contribution-volunteer system" would work to perfection, because the people will always labor enthusiastically and make any amount of sacrifice to resist an attack which is quick, sharp and decisive; but if the service required be continuous, the same ten or twenty years hence as it is to-day, then the interest begins to weaken after a time, the treasury becomes empty and the movement slackens. There is just one place whence the funds for the care of the consumptive poor should come, and that is the tax budget. Is not this a plea for the education, not only of the officials who make up the budget, but also of those who vote them into office?

[1] My reason for selecting alcoholism for comparison is because of the excellent organization of those who oppose it, an organization worthy of being copied for more general use. It should be noted, moreover, that I have treated alcoholism as a disease and have touched upon its death rate only. It is scarcely necessary to add that the moral side, which is of such great importance in this affliction, does not enter the figures as given.

And finally a word as to the second point I mentioned some lines back.

Our young people should get their sanitary instruction from thoroughly competent sources, or they would do better to have none at all, because false teaching is dangerous. Books are often much out of date and it is always better to rely upon the freshly accumulated experience of those who are in touch with the active problems of the day. Even though the hours must be few during which the student is in contact with some one who is master of his specialty, yet the benefit derived greatly surpasses that obtained during a longer period of second-hand teaching.

There is no branch of instruction that lends itself more readily to what has been termed the "alumni lecture course" than does that of sanitary science.

Subsequent to the lecture a thorough quiz could be readily carried on by a person detailed for that purpose, but it should be based upon the points developed by the lecture and the latter should be given by a man who is thoroughly competent and actively engaged in his profession.

W. P. Mason

THE FUTURE OF AGRICULTURAL CHEMISTRY[1]

It may seem uncalled for at a time when agricultural chemistry has been undergoing such rapid evolution and expansion in the United States, to enter upon a discussion of its future. It is, nevertheless, true that conditions are now developing in this and other countries and have reached their culmination in Germany, which make a discussion of this subject not only desirable and timely, but practically imperative.

There is no time when it is so important to bring out correct views as to the nature of the development of an educational movement as when it is feeling some new and enormous impetus. When building progresses slowly and by stages much time is afforded for changes of plan as the work progresses, but where the progress is rapid and one stage follows another in quick succession it is of vastly greater importance that the plans shall have been fully perfected at the outset. The latter situation is certainly now before us so far as concerns agriculture and the sciences closely related thereto. The agitation for the teaching of nature study in its application to agriculture in the primary schools, the introduction of elementary agricultural instruction into the high school, the rapidly increasing demand for collegiate agricultural instruction and the imperative and almost unmet demand for university training as a proper preparation of teachers for the agricultural college and of investigators for the work of the experiment stations, have created a new and unique situation which should be met not only immediately, but most wisely. The present difficulty is not encountered solely at a single stage, but is more or less acute, as concerns the school, college and university. It is therefore of vital importance to recognize the first and most pressing need in order that by meeting it the whole situation may be relieved most quickly and satisfactorily.

The teacher of nature study in the elementary school would naturally be trained in the high school or normal school, but in this line of instruction these schools are lacking; hence there is now coming a demand upon the agricultural college to supply such teachers. The necessity under these conditions for sound instruction in the agricultural college and for men with thorough university training to teach in them, is greater than ever before.

[1] Address of the chairman of the Section of Agricultural and Food Chemistry, delivered at the Baltimore meeting of the association.

This new demand, supplementing that for men to conduct agricultural research in the experiment stations, is creating, in turn, a demand upon the university which is to-day met only in an utterly inadequate degree; and which has forced the Association of American Agricultural Colleges and Experiment Stations to provide in a slight measure for the need, by the establishment of a short, itinerary, periodic graduate school of agriculture. It is obvious that one can no more lift himself by his boot-straps than that this entire situation can be met satisfactorily without an immediate, adequate and wisely planned agricultural educational movement emanating from the university. It must give inspiration to the college, the college to the high school and normal school, and these in turn to the elementary school teacher.

The national government is now lending its aid to collegiate training in agriculture and to agricultural research, but no adequate step has been or is now being taken in the United States to provide the funds for adequately meeting this new demand upon the university. The recent organization of the Graduate School of Applied Science at Harvard University is in line with a gradually growing movement in a number of agricultural colleges and universities.

Private munificence has been wisely lavished to provide university training in theology, medicine, pure science and law, but as regards agriculture the situation is that of neglect. It is indeed surprising that the great basic industry upon which all others depend, which would seemingly be one of the first to receive support, has been almost utterly ignored, neglected or forgotten by our wealthy philanthropists. There are also certain great agricultural research problems like respiration calorimeter studies which are so complex in their nature, so exacting as to expense and the period of years necessary in which to reach definite results, that the experiment stations can at present hardly grapple with them, and still meet the other urgent demands which are made upon them; hence it is hoped that for such work satisfactory, permanent provision may soon be made. In this regard absolutely abstract research has been placed, through private munificence, on a far better plane. In fact this country now needs and awaits the advent of men who feel that these great problems, which by their final solution give promise of direct or indirect aid to agriculture, are also worthy of endowed support; and especially that provision for high-grade university training, in its application to agriculture, and of a pension system for experiment station research workers by which they may be placed on a par with the teachers, would be among the most fundamental, far-reaching and humanitarian projects for endowment.

Sufficient has been said to emphasize the great extent of the present movement for agricultural education and to show that somehow and from somewhere must come far greater support of highly complex agricultural research and especially of agricultural training of a university grade. Indeed, the movement from below is so general, so impulsive, and so powerful, that the situation from the standpoint of the university can not be much longer overlooked. It becomes important, therefore, to consider the place of agricultural chemistry in the university plan. In this connection it is of historic interest to recall that the American student who looked over the field of agricultural chemistry in this country twenty years ago could learn of but five or six teachers of this subject, most of whom were giving only collegiate courses of instruction which were often only partially commensurate with the university courses then offered in Germany. Indeed

it is a noteworthy fact that one of these men (Goessmann) is a German, while among the others were Atwater, Storer, Caldwell and Johnson, who had all derived their inspiration from study at German universities. Thus this country owes a debt of gratitude to Germany which may not be sufficiently appreciated; and notwithstanding the splendid agricultural chemical work done in France, England and elsewhere, Germany has long been looked upon as the mecca for the agricultural chemists of the entire world.

Such having been the case, the situation to-day is of particular interest in view of the attitude of Dr. H. Thiel, of the German Ministry of Agriculture, who at the International Congress of Agriculture at Vienna in 1907 presented and supported a scheme of agricultural education which shall entirely eliminate agricultural chemistry as such, which he designates as a "bastard" of various sciences, a subject essentially dragged in to fill a temporary gap. The effect of such powerful influence is already becoming strikingly evident in Germany, where the professorship of agricultural chemistry in certain cases, as in Göttingen and Halle, has been reduced in grade. Two other universities, Giessen and Kiel, now offer no facilities for the study of the subject under specialists. In Leipsic agricultural chemistry, formerly represented by men like Knop and Stohmann, has now been entirely banished. In certain universities the professors of agricultural chemistry are now given no seat nor vote in the faculties and no less prominent a teacher than the late Dr. Emmerling, of Kiel, was never promoted beyond the grade of "Privatdozent," and even this position has now become vacant. Fortunately at the agricultural "Hochschulen" and "Akademien" the situation is not yet so grave. Nevertheless, Professor Pfeiffer, to whose presentation of the subject I am indebted for the foregoing facts, states that to the best of his knowledge there is not now a single "Privatdozent" in the subject of agricultural chemistry in the entire German empire, from which it would appear that in a few years, if the present policy of Director Thiel is upheld, the student of agricultural chemistry will certainly no longer look to Germany for instruction and inspiration. This view-point of Thiel's appears to be analogous to that of a former president of a purely agricultural college in the United States, who held that when botany, chemistry, physiology, geology, mineralogy, zoology, etc., had been taught, agriculture, essentially a "bastard" of these sciences, had already been taught, and hence agriculture should be utterly eliminated from the curriculum of the agricultural college. Indeed, it is hard to see, if this logic is correct, why chemists should be trained especially in the chemistry of dye-stuffs and dyeing, or indeed in any particular department of chemistry. This same view relative to agricultural chemistry appears to be held by the dean of the college of agriculture and mechanic arts of at least one large university in this country. An even more dangerous and insidious assault upon the field of agricultural chemistry is the encroachment, in the United States, of the field of agronomy, which is becoming more and more apparent with the establishment of independent chemical laboratories in such departments.

"To be, or not to be, that is the question!" Surely if agricultural chemistry has filled its little niche temporarily and has now become superfluous and useless it should be cast adrift without delay; but on the other hand it is well to consider if this is the case. No one will probably dispute that a reasonable familiarity with the whole field of organic, inorganic and physical chemistry should be prerequisite to a course in agricultural chemistry, as well as

in any other special field of technical chemistry, and that a well-trained agricultural chemist should have had fundamental training in physiological botany, physics, geology, mineralogy, general biology and other sciences. This is obvious since the investigator in agricultural chemistry is likely at any moment to be in need of the special knowledge which may be afforded him through other sciences. He may even find it desirable or necessary to associate with himself a specially trained physical chemist, bacteriologist or physiological botanist in the solution of a problem which, approached by a man trained only in any one of those lines, would be as incapable of solution as by him. If for such a cause agricultural chemistry is to be called a "bastard" science and should be eliminated from the university these other sciences deserve it equally. Instances are by no means rare where subjects have been studied from the view-point of a given science and even indeed from that side which would have been considered unquestionably the easiest and most promising line of approach, and yet it has remained for some other man approaching the subject from the point of view afforded by a remotely related science to reach the final solution of the problem. These thoughts lead to the question: Can we afford to lose the view-point afforded by agricultural chemistry, and is not the fundamental fault with it, if such fault exists, that its field has grown to be too wide? In other words, it seems probable that not less, but more, agricultural chemistry is needed in the university and in more concentrated form. In fact, a complaint was made to the writer ten years ago by one of the leading thinkers and workers in this line in Germany, that the field was already so broad, the demands so great, and the literature so voluminous, that it was becoming a mistaken policy in Germany to oblige a professor to cover the whole subject.

In fact, that department of agricultural chemistry which deals with animal nutrition offers by itself a sufficiently wide scope in the special chemistry of the carbohydrates, fats, proteins, gums, resins, enzymes and metabolism, involving as it does so much of the field of the physiological chemist. Presumably, from the position taken by Thiel a study of nutrition from the standpoint of the physiological chemist would be considered sufficient to meet all the necessities of agriculture. It is nevertheless absurd and hopeless to expect the physiological chemist, who approaches his subject more from the view-point of medicine or human hygiene, than of agriculture, to pursue nutrition and metabolic studies with ruminants and other farm animals, excepting in so far as the special problem is calculated to bear upon general principles or upon certain features in their relation to man. On the other hand, it can hardly be expected that the agricultural chemist will fail to concentrate his energies upon the study of these problems very largely in their relation to the nutrition of farm animals. It is important that the subject should be studied independently even notwithstanding the close relationship of the work and the fact that each at many points may touch upon the field of the other. That such close points of contact exist is no suitable argument for discontinuing the work of one or the other, but on the contrary furnishes the strongest reason for the support of each, since by this contact each receives mutual assistance.

There would also seem to be an ample field for the specialized teacher in the line of agricultural chemical technology, for example in the manufacture of fertilizers, sugar, wood pulp, alcohol, vinegar, beer, wine and the vast number of other materials which might be enumerated. In

addition, the field of the chemistry of soils, fertilizers and plant nutrition, entirely aside from the usual scope and direction of the work of the agronomist, is amply broad for one man to cover if he becomes properly familiar with the past literature of the subject, and keeps abreast of the times in connection with the many experimental and analytical features involved. The fact that this field will lead him into touch with, or even at times to encroach upon, that of the bacteriologist, physical chemist, physiological botanist or agronomist, furnishes no ground for the abolishment or restriction of one or the other, but rather emphasizes the importance of maintaining these different points of view, since they are likely at any time to furnish a special vantage ground, or new avenue for the attack upon some difficult problem, which, approached from any other direction, might not admit of solution.

The most hopeful feature connected with the teaching of agriculture in the United States at the present moment is the rapid rate at which the subject is being divided into specialties, for it is only in this way that it can ever be hoped that its students can acquire the best knowledge of the theory and practise in any given line, and no alarm need be felt if these subjects have a close "touch of elbows." When a teacher covers too large a field he is sure to be weak in his knowledge of either the theory or practise and a condition thus arises which interferes with science taking its true place in its relation to the advance of the practise of agriculture in its several departments. Indeed there is little ground for wonderment that the classically educated man who saw, a few years since, a single "professor of agriculture" struggling to cover superficially the whole of his broad field, with little if any of his subject-matter reduced to pedagogic form, should not have been moved to feel that he was merely placing a cheap and useless veneer over the other sciences. If agricultural chemistry is today in a somewhat similar position then surely the time has come when, instead of its being thrown overboard because of its breadth, it should, like general agriculture, be properly subdivided and given the fullest opportunity for its development. It may be claimed that agricultural chemistry covers partially the same field as agronomy and hence should be eliminated; but the attempt to place such artificial barriers between the different sciences and to provide that one shall not encroach upon the field of the other prevents the greatest progress and interferes with the organization of effective and sound research. The need in such cases is provision for sympathetic and hearty cooperation. Indeed, the erection of such barriers is no less pernicious than the elimination of view-point which would come from the pursuit of pure science by itself, in the university, unaccompanied by any attempt to study and teach its application, since each furnishes a stimulus to the other. The additional point of view of the professor of applied science is too valuable to the university to be lost. It is not only vital to the welfare of agriculture and to most of our great industrial undertakings, but is helpful and even inspiring to those pursuing pure science as such.

Apparently the result of the present general movement as represented by Thiel is to remove the higher teaching and research in science as related to agriculture, entirely or largely from the universities and to concentrate it in connection with purely agricultural institutions, such for example as "Landwirtschaftliche Hochschulen." If such a general policy were adopted in this country it would mean adding to our present agricultural colleges the highest grade of university instruction in the sciences related to agriculture, rather than adding

such instruction to the university, where it could be the handmaid of pure science in its highest aspect. It is indeed possible that the former course may yet be followed in this country in consequence of the attitude of the university toward applied science, but if so, it would seem to be in consequence of following the lines of least resistance instead of adopting the wisest, broadest and most effective policy. It would seem that a divorce of science as applied to the great industry of agriculture, from the close and intimate touch with the highest and best in pure science, and from the finest academic atmosphere which the country can supply, would be an equally great misfortune to science in both its pure and applied form. In this connection, it is of the utmost importance that the college and university teacher of science, in its relation to agriculture, as well as men in training for research positions in the agricultural experiment stations, should have approached the university through an agricultural college of as high standing educationally as other institutions of collegiate grade, and that they shall not enter this university field without the close touch with agriculture and with the allied sciences which such agricultural colleges afford, since this is essential to their highest usefulness.

That which is most needed at the present time is to provide university education from the view-point of agriculture, and this ought to have immediate and splendid support.

At a time when agricultural chemistry is "under fire" it is especially fitting to consider its requirements and to judge it by its fruits. The very nature of the subject brings the teacher of agricultural chemistry in the college, and the experiment station investigator in close touch with the farmer and hence a knowledge of practical matters is indispensable to his highest success and usefulness, a requirement which has forced from the ranks some of the general chemists who have tried to enter the field of agricultural chemistry. The conditions imposed have made the field a particularly favorable one for the young man who has been reared on the farm, who has had an agricultural college education and who is thus in position not only to give the farmer the advice and counsel which he seeks, but also to be governed by sound judgment in his scientific deductions in their bearing upon agricultural matters. The very fact that a more or less general knowledge of several sciences, and thorough training in general chemistry are required, has forced the student in this line to prepare himself more fully for his work in the past, than in many of the other sciences related to agriculture. These combined features furnish a splendid preparation for the administrative duties devolving upon the director of an agricultural experiment station. In fact it is doubtless due to these considerations that a great proportion of the agricultural experiment station directors in this country and in Europe have been chosen from the ranks of the agricultural chemists. Thus this science has yielded special fruit by way of leaders in agricultural investigation in addition to its vast number of other contributions to our general agricultural progress.

It is needless to cite what the agricultural chemist, from the time of Liebig to that of Hellriegel, has contributed to agriculture; since the men and their work are too well known and appreciated to require enumeration. It can not be disputed that without the aid of agricultural chemistry modern agricultural progress would have been impossible and the world would now be crying for food. Indeed, even a casual survey of the fruits of agricultural chemistry and of its benefactions to the people justify not only its past existence, but for

the future far greater and more general recognition in the universities, where it should receive at once magnificent support and endowment. Now is the time for us to seize upon this inheritance which Germany seems about to relinquish!

H. J. Wheeler

Rhode Island Agricultural
Experiment Station,
Kingston, R. I.

SCIENTIFIC NOTES AND NEWS

The two volumes containing "The Collected Papers of Joseph, Baron Lister," will shortly be issued from the Clarendon Press. They were planned as a memorial of Lord Lister's eightieth birthday, celebrated two years ago. The committee formed for the purpose has had the advantage of Lord Lister's advice, and the two volumes contain all the papers and addresses which he considers to possess permanent value.

Professor H. F. Osborn, of Columbia University, has recently been elected one of the twenty-five foreign members of the Zoological Society of London, and also an honorary member of the Royal Academy of Sweden, as the successor of the late Professor Albert Gaudry.

Prince Albert of Monaco has been elected a foreign member of the Paris Academy of Sciences in succession to Lord Kelvin.

Edinburgh University has conferred the honorary degree of LL.D. on Mr. J. G. Bartholomew, hon. secretary Royal Scottish Geographical Society; Professor A. Crum Brown, F.R.S.; Professor W. Burnside, F. R.S., Royal Naval College, Greenwich; Sir Alfred Keogh, K.C.B., director-general of the Army Medical Service, and Professor C. H. Kronecker, University of Berne.

Sir Richard D. Powell has been reelected president of the Royal College of Physicians of London.

Dr. Clemens von Pirquet, of Vienna, has been appointed physician-in-chief to the Harriet Lane Home for Invalid Children, affiliated with the Johns Hopkins Hospital and professor of pediatrics in the university.

Dr. Oliver L. Fassig, of the U. S. Weather Bureau, Baltimore, and the Johns Hopkins University, has been placed in charge of the Porto Rican station with headquarters at San Juan.

Professor H. E. Gregory, of the geological department of Yale University, will, on behalf of the U. S. government, undertake an expedition to the Arizona desert to seek a water supply for the Navajo Indians living on the Arizona reserve.

The annual business meeting of the Phi Beta Kappa Alumni in New York will be held in the Hotel Savoy on the evening of May 4, when Dr. Simon Flexner, director of the Laboratories of the Rockefeller Institute for Medical Research, will address the association on the subject "The Service to Medical Science of Independent Institutions for Medical Research."

Professor Joseph Barrell, of Yale University, gave a series of lectures in the department of geology at the University of Wisconsin from March 31 to April 6, dealing especially with sedimentation in some of its more modern aspects.

At the 353d regular meeting of the Middletown Scientific Association, held in the Scott Laboratory of Physics, Wesleyan University, on April 13, Dr. Arthur Eugene Watson, assistant professor of physics in Brown University, gave an illustrated lecture on "Some Mile-stone Marks in Electrical Engineering."

A meeting of instructors and advanced students at Harvard University for the discussion of a recent chemical research will be held in Boylston Hall at 5 o'clock on the following Thursdays: April 29, May 6, 13, 20 and 27, and June 3. The next meeting will be open to all members of the university, and the special subject will be "The Rusting of Iron," by Dr. Allerton S. Cushman, of the U. S. Department of Agriculture.

Under the auspices of the department of physics of Columbia University a course of lectures on "The Present State of the System of Theoretical Physics," will be given by Max Planck, Ph.D., professor of mathematical

physics in the University of Berlin, lecturer in mathematical physics in Columbia University, 1908–1909. The lectures will be given in German on Friday afternoons at 4:10, and Saturday mornings at 10:10 from April 23 to May 15.

April 23 and 24—Introduction. "Reversibility and Irreversibility."

April 30 and May 1—"Kinetic Theory of Matter."

May 7 and 8—"Radiation of Heat."

May 14 and 15—"General Dynamics. The Relativity Principle."

Frank Leo Tufts, B.S. (Antioch, '91), A.B. (Harvard, '94), Ph.D. (Columbia, '96), adjunct professor of physics in Columbia University and the author of valuable contributions to experimental physics, was killed by an electric shock, on April 15. He was born in Findlay, Ohio, in 1871.

Dr. W. H. Edwards, known for his work on the butterflies of North America, died at Coalburo, West Virginia, on April 4, at the age of eighty-eight.

The death is also announced of the Rev. Dr. Sereno E. Bishop, who had spent more than fifty years as an American missionary in the Hawaiian Islands and had made contributions to our knowledge of their volcanoes.

There will be a New York State civil service examination on May 1 for the position of assistant bacteriologist in the State Department of Health at a salary of $1,500.

A North Dakota Academy of Science has been organized and will hold a spring meeting at Grand Forks on May 21. At this meeting Professor M. A. Brannon will outline the work that is before the academy in the biological sciences; Dr. Geo. Stewart that in the physical sciences, and Professor D. E. Willard that in geology. The first two named are in the State University at Grand Forks and the last is in the Agricultural College at Fargo. The president of the academy is Professor H. A. Brannon, of the State University, and the secretary is L. B. McMullen, of the State Normal School.

Plans for the Pacific Coast meeting of the American Institute of Mining Engineers provide for a visit to Yellowstone Park, September 25 to 30; Spokane, October 2 to 6; Seattle, October 8 to 11; Tacoma, October 12, and Salt Lake City, October 15 to 19. The special train is to leave New York, September 22, and return just a month later.

The semi-annual meeting of the American Institute of Chemical Engineers will be held on June 24 and 25 at the Polytechnic Institute, Brooklyn, N. Y. The program will consist of papers, excursions and an exhibit of chemical engineering apparatus.

A conference on public health is being held this week at the University of Illinois under the auspices of the university and the Illinois State Board of Health. Professor W. T. Sedgwick, of the Massachusetts Institute of Technology, will deliver a series of lectures on the general subject, "Science in the Service of Public Health." Dr. T. J. Bryan, chemist of the Illinois State Food Commission, will speak on "The Relation of Pure Food to Public Health." A special session of health officers will be held on April 23, for general discussion of problems of health in the state. Dr. Egan, secretary of the State Board of Health, will open this session.

Dr. F. Creighton Wellman, who has had long experience as health officer in Portuguese East Africa, gave a series of extensive lectures under the auspices of the medical department of Tulane University on the following dates and subjects:

April 12—"Insects and Human Diseases."

April 13—"Diseases of West Africa."

April 14—"A Naturalist in West Africa."

April 15—"Why the Physician in Temperate Climates should study Tropical Diseases."

April 16—"General Biological Conditions in West Africa."

April 17—"Anthropological Notes made in West Africa."

A course of eight free popular lectures was given at the Chicago Academy of Sciences on Friday evenings during February, March and April, as follows:

February 19—"The Volcano of Kilauea," by Mr. William A. Bryan, president, The Pacific Scientific Institution.

February 26—"The Deserts of Arizona," by

Dr. Henry C. Cowles, assistant professor of ecology, University of Chicago.

March 5—"Studies in Geology: The Grand Canyon of the Colorado River," by Dr. Wallace W. Atwood, secretary of the academy.

March 12—"Studies in Geology: The High Mountains of North America," by Dr. Wallace W. Atwood, secretary of the academy.

March 19—To be announced.

March 26—"The Conservation of our Natural Resources," by Mrs. Jane Perry Cook, head of department of geography, Chicago Normal School.

April 2—"Studies in Geology: The Geological History of the Chicago Region," by Dr. Wallace W. Atwood, secretary of the academy.

April 9—"Travel and Exploration in Alaska," by Dr. Wallace W. Atwood, secretary of the academy.

The Geographic Society of Chicago has arranged for the month of May two excursions, the regular excursion on the second Saturday of the month and a special one later in the month. The regular excursion will take place on Saturday, May 15, under the leadership of Dr. Otis W. Caldwell, of the University of Chicago. The region visited will include the rich woods and the remarkable moving dunes near Furnessville, Indiana. The special excursion for May will be to Starved Rock and the Canyons of the Illinois River. Specialists will give the history of the region, explain its topography, and interpret its flora and avifauna. The society is actively supporting a measure now before the legislature looking to the incorporation and preservation of Starved Rock and its environs within the confines of a State Park.

We learn from *Nature* that the Royal Physical Society of Edinburgh has opened its doors to women members. At the March meeting of the society, Mrs. Elizabeth Gray, Edinburgh; Miss Marion I. Newbigin, D.Sc., Edinburgh; Mrs. Ogilvie Gordon, D.Sc., Ph.D., Aberdeen, and Miss Muriel Robertson, London, were elected ordinary fellows.

The U. S. Geological Survey has just opened at Denver a permanent branch office to facilitate the transaction of its western work, thus providing a base of supplies for the large corps of engineers who are kept in the field many months each year, making geologic studies of mineral deposits, conducting detailed topographic surveys for the base maps of the geologic atlas of the United States, mapping the great national forests, investigating surface and underground waters, and collecting statistics of mineral production. The establishment of such a branch office is not only intended to serve the convenience of the survey corps, but it is designed also to meet the great need of the western public for a source of information less remote than Washington. A supply of copies of the publications available for free distribution will be kept on hand, as well as a complete file of the topographic maps, geologic folios, and other publications of the survey subject to sale. All of these publications will be open to inspection by persons desiring information concerning the subjects treated. Prospective purchasers of maps and folios will be referred to the nearest sales agent, and the free publications will be distributed in Denver to those making application. In short, the Denver office is intended to serve the public in all matters that lie legitimately within the province of the United States Geological Survey. The office is located in the Commonwealth Building and was opened on the first of April. R. C. Miles, special disbursing agent, is at present in charge, and will answer all inquiries, distribute documents, and maintain a visitors' register.

UNIVERSITY AND EDUCATIONAL NEWS

At the recent annual celebration of Founder's day at the University of Virginia, President Alderman announced that an endowment fund of $1,000,000 had been completed during the past year. Between November and February $750,000 of this total was secured in sums as follows: Andrew Carnegie, $500,000; Oliver H. Payne, $50,000; children of John B. Cary, $20,000; Christian Woman's Board of Missions, $30,000; Thomas F. Ryan, $25,000; Charles H. Senff, $25,000; Charles Steele, $30,000; Robert Bacon, $10,000; H. McK. Twombley, $10,000; General Education Board, $50,000. The $500,000 given by Mr. Carnegie will become the per-

manent endowment of six existing schools in the university, and these schools are to be given the names as follows: The James Madison School of Law, the James Monroe School of International Law, the James Wilson School of Political Science and Political Economy, the Edgar Allan Poe School of English, the Andrew Carnegie School of Engineering, the Walter Reed School of Pathology.

GIFTS to Princeton University for the quarter ending with the spring recess aggregated $145,939. $100,000 was presented by Cleveland H. Dodge, '79, of New York, for part of the endowment of Guyot Hall, the new natural science laboratory now under construction on the eastern side of the campus. A fund of $400,000 was presented some time ago for the construction of the building, which is now nearing completion. The next largest gift came from the committee of fifty alumni who are raising funds by subscription for the immediate needs and future development of the university. This committee turned in a total of $38,039 for the quarter, $28,039 of which goes to current expenses and $10,000 for endowment.

EXERCISES appropriate to the opening of the new engineering building of Rutgers College, erected at a cost of $100,000, were held on April 14. The building contains seven classrooms, five laboratories, six professors' offices, and three draughting rooms. It is used by the departments of civil, electrical and mechanical engineering.

THE University of Pennsylvania correspondent of the New York *Evening Post* states that the cosmopolitan character of the student body at the university was emphasized at the recent formation of the Cosmopolitan Club, the object of which is to hold occasional meetings, when an opportunity will be afforded to men of all nationalities to become acquainted with each other, and to discuss matters of common interest. It is planned to hold, next year, a series of "national nights," where the customs of each country will be presented by its representatives. It was found that there are 120 students in the university from the Latin-American countries, 50 students who are British subjects, and 31 who are Chinese. There are 32 other countries represented in the student body.

DR. A. A. MURPHREE, president of the State College for Women at Tallahassee, has been elected president of the University of Florida.

DR. R. C. HUGHES has resigned the presidency of Ripon College.

J. F. MESSENGER, A.B. (Kansas), A.M. (Harvard), Ph.D. (Columbia), professor in the department of psychology and education of the State Normal School at Farmville, Va., has been called to the University of Vermont.

M. DANGEARD, editor of the *Botaniste*, professor in the faculty of Poitiers, has been called to a chair in the faculty of sciences at Paris.

DISCUSSION AND CORRESPONDENCE

THE FUNDAMENTAL LAWS OF MATTER AND ENERGY

TO THE EDITOR OF SCIENCE: In a recent number of *The Technology Quarterly* (June, 1908) appears an article by Professor Lewis entitled "A Revision of the Fundamental Laws of Matter and Energy." It closes with the following summary:

> It is postulated that the energy and momentum of a beam of radiation are due to a mass moving with the velocity of light.
>
> From the postulate alone it is shown that the mass of a body depends upon its energy content. It is, therefore, necessary to replace that axiom of the Newtonian mechanics according to which the mass of a body is independent of its velocity by one which makes the mass increase with the kinetic energy.
>
> Retaining all the other axioms of the Newtonian mechanics and assuming the conservation of mass, energy and momentum, a new system of mechanics is constructed.
>
> In this system momentum is mv, kinetic energy varies between $\frac{1}{2}mv^2$ at low velocities and mv^2 at the velocity of light, while the mass of a body is a function of the velocity and becomes infinite at the velocity of light. The equation obtained agrees with the experiments of Kaufmann on the relation

between the mass of an electron and its velocity. It is, moreover, strikingly similar to the equations that have been obtained for electromagnetic mass.

The new view leads to an unusual conception of the nature of light. It offers theoretically a method of distinguishing between absolute and relative motion.

Mass is defined by Professor Lewis as momentum (M) divided by velocity (v),

$$m = M/v.$$

I should like to say a few words about this summary and the paper to which it belongs.

The notion of momentum in a beam of radiation is introduced with the aid of the "law of conservation of momentum." The other two laws required, of the three in all, are the conservation of energy and the conservation of mass.

For the sake of argument, I shall assume a beam of radiation to consist of a mass in motion and proceed to consider the use of such a hypothesis or conception.

What happens when that beam impinges on a body? That the body receives energy and that this energy is shown by the movement of the body is settled beyond doubt by experiment, but that the moving mass in the beam sticks to the body it strikes is very questionable. How can it stick to a body which radiates as much energy as it receives and of the same nature? Professor Lewis does not seem to consider this difficulty. But, for the sake of argument again, I assume that what is mass in the beam of radiation does adhere to the body it strikes. Then, of course, the mass of the body struck increases as it moves and increases as it receives this particular form of energy, but only as it receives *this particular form*. Yet Professor Lewis considers this increase of mass with energy as typical and concludes that because the mass of a body increases as it receives radiant energy, to which he assigns a very special constitution, therefore its mass increases when it receives any energy whatsoever and diminishes when it loses any energy whatsoever. Otherwise, what does the following mean:

> Assuming the fundamental conservation law [of momentum? C. L. S.], we must regard mass as a real property of a body which depends upon its state and not upon its history. Hence it is obvious that if in any other way than by radiation the body gains or loses energy, it must gain or lose mass in just the above proportion [see equation (5) below, C. L. S.]. In other words, any change in a body's content of energy is accompanied by a definite change in its mass, regardless of the nature of the process which the energy change accompanies.

This seems to me equivalent to saying that all energy is of the same nature as radiant energy, a notion not acceptable in the present state of our sciences. Professor Lewis thinks that consequently one of the axioms of Newtonian mechanics must be changed. I suppose he refers to axiom 1, but none of the three says a word about this relation. They imply this independence of mass and velocity, but were they to be found dependent, I can not see that any of the three would be changed, necessarily, in wording. I do not find in this whole development anything more than a special kind of action, one that can not be generalized at all. A ship bombarded by projectiles and moving in the same direction as the projectiles continues in the same direction as before with increased mass and increased velocity due to the mass and energy of those missiles. But who would draw any general conclusions as to the nature of all the other energies from this? It is a very easily analyzed case, but I do not see how it differs in principle from the more obscure one of radiant energy.

The change in mass for a given quantity of energy is calculated by Professor Lewis thus:

The moving mass of the beam imparts dE of energy in dt time, so in t time it imparts $(dE/dt)t$ of energy. During this time t, a quantity of energy has traveled up to the body absorbing the radiation and been delivered to it equal to fs where f is the radiation force ~~pressure~~ and s is the distance the radiation has traveled in t time. Making t equal to unity, s becomes the velocity of radiation, V. Then,

$$f = dE/Vdt. \tag{1}$$

By condition, this f, being due to a moving

mass, imparts momentum dM in time dt and so,

$$f = dM/dt. \tag{2}$$

With (1) and (2),

$$dE/dM = V. \tag{3}$$

But a momentum from a mass dm moving with a velocity V requires that

$$Vdm = dM, \tag{4}$$

and so with (3),

Lewis no. 7

$$dm = dE/V^2. \tag{5}$$

Now equation (5) is a very simple thing. It gives the mass needed at velocity V to produce the energy dE in this special way. But Professor Lewis says this equation gives the *change in mass when the energy of the body changes by dE in any manner whatsoever*. I do not see that this inference is legitimate at all.

In the fourth paragraph there is the startling statement that the mass of a moving body becomes infinite at the velocity of light. It seems to me this at once throws suspicion on the line of reasoning leading up to such a conclusion. Professor Lewis recognizes this difficulty for he says, "Therefore that which in a beam of light has mass, momentum and energy, and is traveling with the velocity of light, would have no energy, momentum or mass if it were at rest, or, indeed, if it were moving with a velocity even by the smallest fraction less than that of light," adding with great naïveté, "After this extraordinary conclusion it would at present be idle to discuss whether the same substance or thing which carries the radiation from the emitting body continues to carry it through space, or, indeed, whether there is *any substance or thing connected with the process*." (Italics mine, C. L. S.) Moreover, I do not see how this part of the fourth paragraph is consistent with (5). There is no special value, numerically, to be assigned to V in deducing (5) and so there can not be an extraordinary jump from a finite to an infinite value when V has a certain finite value assigned it. We have no right to assume that the velocity of light is the greatest possible velocity in the universe. What would the mass become for a greater velocity? What does the mass become for the lesser velocity of light in water?

It seems to me that there is no need for any such startling conclusion. In fact, no opportunity for it, as I think will be seen from the following.

A beam of radiant energy composed of a moving mass changes the momentum of the body struck by it both by the change in velocity and by the change in mass due to the mass of the beam passing into the body struck by the beam. Hence, from the definition of momentum, $M = mv$,

$$dM = mdv + vdm. \tag{6}$$

Replacing in (4),

$$Vdm = mdv + vdm,$$

or

$$dm/m = dv/(V - v).$$

In this equation, V is the velocity of the striking mass of the beam, the mass of which is dm, while v is the velocity of the object struck whose mass is m, and dv is the velocity imparted to it, to the mass m. Consequently, this equation expresses the relation between the change in mass of the object struck, due to the accretion from the mass of the beam, and v, the velocity of the object, due to the impact of the beam mass. Integrating,

$$m/m^0 = V/(V - v) \tag{7}$$

where m^0 is the mass of the object at rest, that is, when v is zero. When v is V, its mass becomes infinite, which means that a mass aggregating to an infinite mass must accumulate on the object before it will attain a velocity equal to the velocity of the pelting mass of the beam. In other words, the mass of the object must become relatively zero and not absorb any of the kinetic energy of the beam for itself, to increase its motion. This is surely simple! Who would conclude from this that when a body is given a velocity equal that of light in any way whatsoever its mass becomes infinite? Yet this is what Professor Lewis seems to do. He deduces his equation in a somewhat different way, passing through the energy and not through the momentum,

but coming out with an equation of the same nature as 7. As I understand it, he proceeds as follows:

Combining (1) and (2), for any velocity,

$$dE = vdM,$$

and replacing dM from (6) and dE from (5),

$$V^2dm = vmdv + v^2dm.$$

Integrating,

$$m/m^0 = V/\sqrt{V^2 - v^2}, \tag{8}$$

in which as before, when v is zero, m is m^0, the mass of the object at rest, and when v^2 is V^2, the mass is again equal to infinity, for the same reason as given previously. Professor Lewis interprets this equation thus: "According to equation (8), any body of finite mass increases in mass as it increases in velocity, and would possess infinite mass if it could be given the velocity of light."

Consider a body in a rarefied atmosphere and set in motion by the gas particles. It seems to me that Professor Lewis's reasoning will apply equally here, and then a body moving with the velocity of the gas particles should gain infinite mass. According to my interpretation of the equations, when the body did gain the velocity of the gas particles, an infinite number of them, an infinite mass, would have accumulated on the object.

I am inclined to think myself that these troubles of mine are due to unfortunate wording. If so, Professor Lewis ought to make the thing clearer, as it is very important, and I am sure many others have the same difficulty I have in harmonizing the article with one's experiences and reasoning powers.

CLARENCE L. SPEYERS

CAMBRIDGE, MASS.,
December 14, 1908

MARS AS THE ABODE OF LIFE[1]

ALTHOUGH it is improbable that these lines will be read by more than a small proportion of those who have seen or heard of Mr. Percival Lowell's "Mars as the Abode of Life," it seems worth while to point out to the scientific workers of the country the gross errors which this book is propagating. In this I shall confine myself to geological matters, leaving the astronomical and other questions to those who have special acquaintance with such things. It is not surprising that Mr. Lowell, an astronomer, should have only a layman's knowledge of geology; but that he should attempt to discuss critically the more difficult problems of that science, without, as his words show, any understanding of the great recent progress in geology, is astonishing and disastrous. One can not but recall the adage that "fools rush in where angels fear to tread."

Mr. Lowell is an implicit believer in the Laplacian theory of planetary evolution, a hypothesis now on the defensive, to say the least, and utterly abandoned by some of our best cosmogonists.

On an adjacent page he says that the minerals of the metamorphic rocks "show by their crystalline form that they cooled from a once molten state." The fallacy in this statement is evident to the average college student of geology or chemistry. Metamorphic rocks are produced by processes which involve more or less pressure and heat, but not melting.

Turning to consider the evolution of life on the earth, the author tells us that "the geologic record proves that life originated in the oceans. . . . Whether life might have generated on the land we do not know; on earth it certainly did not." The truth is that the geologic record proves nothing whatever about the origin or even the infancy of life. It may be fairly doubted whether it takes us back even to the middle age of the animal kingdom. Such a dogmatic assertion is, therefore, wholly unjustified. In this connection it is hard to resist pointing out that among the oldest known fossils are certain Eurypterids (Walcott's *Beltina danai*) which are generally interpreted as fresh-water rather than marine forms.

Farther on we read, of the plants which formed the Carboniferous coal beds, "Only a warm, humid foothold and lambent air could have given them such luxuriance and im-

[1] A series of lectures delivered before the Lowell Institute, Boston; later published in the *Century Magazine*, 1908; and subsequently issued as a volume by the Macmillan Company, New York, 1908.

pressed them with such speed." Neither Mr. Lowell nor any one else knows whether the vegetation in the Carboniferous swamps grew slowly or rapidly. We know only that they produced a certain body of coal. That may have taken a short time at a rapid rate, or a long time at the slow rate; the results would be the same. As to the warmth, it may be remarked that coal seams are now in process of growth in Alaska and Labrador and that many of the Carboniferous plants show by their structures an adaptation to severe rather than genial climatic conditions. Only a little later than the Carboniferous period most of the lands adjacent to the Indian Ocean experienced a glacial period, comparable to that of recent times in Canada; and in Australia the coal seams are interbedded with layers of glacial drift. Does this bespeak a torrid climate in middle latitudes at that time? Even the moist conditions seem to have been, as now, of local prevalence only, for aridity is indicated by the Carboniferous red beds and gypsum of Colorado and some other regions.

One of the terrestrial conditions which Mr. Lowell finds it necessary to postulate in order to bolster up his theory of Martian evolution is a perpetual cloud envelope around the earth down to about Mesozoic times—"a shady half-light" which he says is attested "by the habit of the ferns of to-day." That tree-ferns now stand out isolated on the brushy hills of equatorial Africa under the blazing tropical sun is evidently unknown to the author. Under the circumstances he would have found the services of a botanist advantageous.

With the hypothesis of a perpetually damp cloudy atmosphere we can hardly reconcile the existence of deserts in India in the Cambrian, in New York in the Silurian, in Michigan and New Brunswick in the Carboniferous, and in Germany in the Permian period. Yet the testimony of the rocks is emphatic that they did exist in those times and places.

Another of the author's preconceived opinions of Mars, which the history of our own planet has been twisted and squeezed to fit, is the shrinkage of the oceans and the eventual disappearance of water in any form. According to Mr. Lowell, Mars had oceans but lost them, and the earth is merely in an earlier stage of the same process. As to the earth, he says, "observation proves this to be a fact," and goes on to cite Professor Dana, who many years ago propounded the opinion that the lands had grown steadily larger from small beginnings. If Dana were alive to-day he would doubtless repudiate the idea, for it is wholly contrary to the mass of facts more recently made known. If Lowell were right, land on the continent of North America would have been smallest in the Archean and be greatest now. The truth is that there have been fluctuations of land and sea throughout recorded geologic history, and these changes show no general tendency. Just before the Cambrian period the continent was nearly all out of water; at the close of that period it was at least half submerged. At the close of the Permian it emerged more extensively than ever and yet in the Cretaceous it was again deeply inundated. Examples of the same thing could be largely multiplied, but are too well known to make that necessary.

In the face of all these facts Mr. Lowell coolly states that "wherever geologists have studied them, the strata tell the same tale," viz., the land has spread, the ocean shrunk.... No competent geologist would admit a word of this. Yet on this comfortable basis of fallacy Mr. Lowell then proceeds "Now, a general universal gain of the sort can mean only . . ." One is tempted to direct the author's attention to his own preface wherein he seriously admonishes that "the cogency of the conclusion hangs upon the validity of each step in the argument." The reader can judge for himself of the cogency of this particular conclusion.

Having assured his readers that the earth is drying up and that it will sooner or later "roll a parched orb through space," he cites as proof the alleged fact that deserts are increasing in size. This is the beginning of the dreadful end which "is as fatalistically sure as that to-morrow's sun will rise, unless some other catastrophe anticipate the end." Here again the proverb applies, "a little knowledge is a dangerous thing." Mr. Lowell

has seen the petrified stumps and trunks of trees in the Arizona desert and jumps to the conclusion that deserts in general have been steadily invading once forested regions, from remote ages onward. Had he inquired into the recorded facts of geologic history he would have learned that deserts have existed in many parts of the world ever since the earliest periods, wherever the topographic and atmospheric conditions were favorable. It is not probable that our present deserts are more extensive than those of the Permian period, during which the saltest of salt lakes partially covered the site of Germany.

I think enough has been said to show what kind of pseudo-science is here being foisted upon a trusting public. "Mars as the Abode of Life" is avowedly a popular exposition of a science, not a fantasy. Its author is a highly educated man of distinguished connections and some personal fame. He writes in a vivid, convincing style, with the air of authority in the premises. The average reader naturally believes him, since he can not, without special knowledge of geology and kindred sciences, discern the fallacies. He has a right to think that things asserted as established facts are true, and that things other than facts will be stated with appropriate reservation. This is precisely the same as his right to believe that the maple syrup he buys under that label is not glucose, but is genuine. The misbranding of intellectual products is just as immoral as the misbranding of the products of manufacture. Mr. Lowell can not be censured for advancing avowed theories, however fanciful they are, for it is the privilege of the scientist; nor for making unintentional mistakes in fact, for that is eminently human. But I feel sure that the majority of scientific men will feel just indignation toward one who stamps his theories as facts; says they are proven, when they have almost no supporting data; and declares that certain things are well known, which are not even admitted to consideration by those best qualified to judge. Censure can hardly be too severe upon a man who so unscrupulously deceives the educated public, merely in order to gain a certain notoriety and a brief, but undeserved, credence for his pet theories.

Eliot Blackwelder
University of Wisconsin,
March 26, 1909

SCIENTIFIC BOOKS

L'Europe Préhistorique. Principes d'Archéologie Préhistorique. By Sophus Müller. Translation from the Danish, by Emmanuel Philipot. Paris, J. Lamarre, Editeur. 1907. Pp. 212, text-figures 161, colored plates 3.

There was a time when civilization did not exist. When did it begin to be and whence came it? Sophus Müller believes it was transplanted into Europe from the Orient. The author has endeavored to confine his work to those elements in prehistoric archeology about which authorities are in accord.

Not much space is devoted to the paleolithic period. France is taken as a center and as the region that shows to best advantage the various stages of paleolithic culture. The reindeer epoch is lacking in Italy, as one might expect, although specimens of the Solutrean and Magdalenian types are found there.

The first epoch of the neolithic period in Italy was synchronous with the last epoch of the paleolithic period in France; the culture of middle Europe being only the periphery of a civilization more advanced in the south.

According to Müller there was in central Europe only one great period of cold after the warm climate of the Chellean epoch when man appeared for the first time. The temperature dropped during the Solutrean and became very cold in the Magdalenian, to grow milder again until the present time. He also believes the paleolithic period to be much shorter than the time ascribed to it by many geologists, notably Penck.

A chapter is devoted to the changes that came with the appearance of the neolithic period in central and northern Europe, especially the differences in the fauna and the similarities among the artifacts. The importance of Piette's discoveries of a transitional industry in the cavern of Mas d'Azil

(Ariège) is noted, as well as similar finds in northern Germany, Russia and Denmark. The north was colonized at a later epoch than were western and southern Europe, Müller placing the date at about 6000 years B.C.

The appearance of the stone ax, chipped but not polished, is what marks the beginning of the neolithic period. It was in the kitchen middens of Denmark that the two principal forms of this ax were first recognized. These shell heaps seem to have been the dwelling places of the people, as numerous hearths are found in them. Here implements were made and repaired. Sherds of a coarse pottery without ornament are also found. Two types have been determined: large jars with pointed bottom, and shallow bowls. The dog was already domesticated, but had evidently been brought to the Danish peninsula from southeastern Europe. The stone axes of the kitchen midden types are found not only to the eastward as far as Russia, but also in southern England, over France, where it characterizes the so-called Campignian epoch, and in Italy. This is also the epoch of small arrow points with transverse edge.

But it would be an error to suppose that the civilization of the north and of the south had the same aspect. New elements were replacing the old in Italy long before they reached Denmark. On the other hand, the tardiness on the part of the latter country was an important factor in the splendid development of its local neolithic industry.

With the second stage of the neolithic period appeared the polished stone ax, a much better tool than its predecessor. It ushered in a period of general industrial development that continued uninterrupted for about 2,000 years. In the Balkan peninsula, Greece, Italy and Spain, none of the polished stone axes are of flint, although this material was used in the manufacture of other tools and arms. A striking example of this is afforded by the prehistoric station of Butmir near Sarajevo, Bosnia, where about six thousand axes and chisels were found and not one made of flint; although there was plenty of flint in the neighborhood and it was used in other forms. North of the Alps, on the contrary, polished flint implements occur with increasing frequency until England and Scandinavia are reached. This state of things is no doubt due to the longer duration of the neolithic period in the north and to the amount of labor required to polish flint.

The art of polishing stone implements evidently originated in the Orient, as did the other characteristic element of the later neolithic, *i. e.*, the geometric ornament on the pottery that replaced the realistic art of the paleolithic. This epoch was preeminently influenced by the domestication of animals. To the dog were added the sheep, the goat, the hog and ox. Agriculture became more and more important. Wheat, barley and millet were all cultivated and all came from the Orient, as did the domestic animals. The people became less and less nomadic in their mode of life. They lived for the most part in villages composed of huts half underground. These followed one general plan—a round or oval excavation covered by a roof of branches and reeds and strengthened by the application of clay. This type of dwelling spread over Europe as far as Scandinavia and persisted for centuries. It was during this epoch that the first burials properly so-called were made. They were similar to present-day burials in that they were simple ditches sunk in the ground and were individual sepultures as opposed to the communal sepultures of the caverns; or of the dolmens of a later period. The dead were placed on the side, with arms sharply flexed at the elbows, bringing the hands to the region of the face; and the legs folded, bringing the knees near the breast. The same mode of burial was practised during the neolithic period of Egypt. Curiously enough, the same method of burial was used by the Indians of southern Connecticut before the advent of the Europeans.

Only 6,000 years is given for both the paleolithic and the neolithic period in Egypt, *i. e.*, from 10000 B.C. to 4000 B.C. For southern Europe the first epoch of the neolithic period is supposed to have begun about 5000 B.C., and the second epoch of the neolithic about 4000 B.C. These epochs began about 1,000 years later, respectively, in Scandinavia.

Copper was employed first in the Orient. It was known in Egypt as early as the first dynasty, about 5000 B.C. But its use was restricted and stone implements, particularly as cutting tools, were very generally employed until 3000 B.C. The Egyptian influence on the pre-Mycenæan civilization is noted and the characteristic stone burial cists of that epoch are described.

The beginning of the proto-Mycenæan epoch is placed at about 2000 B.C. With it appeared pottery of a new and much-improved order. The paste was fine, the modeling excellent and the ornaments in color. This epoch is known in Sicily, southern Italy and Sardinia by the sepulture *a forno,* so named because of its resemblance to an oven. Tombs of this type were communal and placed by preference in the flank of an escarpment. There also existed in these regions the dolmen proper. The two types of communal tomb are genetically related to the pre-Mycenæan stone cist. Strange to say, the dolmens spread to western Europe, Great Britain and Scandinavia, but did not replace in central Europe the ancient custom of individual burials.

The epoch of transition from the neolithic to the bronze age is called the "eneolithic" and corresponds to the Mycenæan. It was preeminently the age of the poniard, the spear and the lance coming later. Properly speaking, there was no eneolithic epoch in Scandinavia, although this epoch had a profound influence on northern civilization. For example, the flat-poled flint ax so characteristic of the north, and which is more recent than the flint ax with pointed pole, seems to have been copied after the copper axes of southern Europe at a time when metal was rare in the north and flint was plentiful. The dolmen also that characterized the eneolithic of the Mediterranean countries was introduced into Scandinavia during the first part of the neolithic period. The flint mines of Sicily and of Belgium are of the same type; but the former were worked by an eneolithic people and the process was borrowed by the races of Belgium before they emerged from a purely neolithic age. Not only flint, but also obsidian remained an article of merchandise well into the bronze age. Obsidian is easily traceable to its original sources in Italy, Sicily and certain islands of the Ægean sea. The finest example of the diffusion of flint from a single source is that of the Grand-Pressigny (Indre-et-Loire) which is recognized by its color and has been traced not only all over France, but also into neighboring countries.

Müller enumerates the fundamental principles that should guide one in studying the relations of the central to peripheral civilizations as follows:

1. Southern Europe represented the active productive civilizing force, while the countries to the north, being peripheral, played a receptive rôle.

2. The civilization of the south was transmitted only in abridged and modified form; subject in the more remote regions to a further development along entirely new and original lines.

3. Types of tools, weapons, apparel and ornaments may persist with but little change for a considerable lapse of time.

4. Elements which along the Mediterranean belonged to successive periods may become contemporaneous in the peripheral regions.

These principles were understood by the men who founded the science of prehistoric archeology during the last century. Müller believes that Montelius would make the prehistoric epochs of the peripheral region follow too closely those of the center. He also does not agree with Penka that Scandinavia itself was a center, a source of civilization; nor with Reinach, who regards Europe as independent of the Orient.

A chapter is devoted to the closing epoch of the neolithic period in the north, where stone art reached its apogee. The finest examples are the flint poniards that are so common in the dolmens of this epoch and that have their prototype in the bronze age—poniards of southern Europe. No such development of the later neolithic is to be found in the countries bordering on the English Channel, because the development in stone art was cut short by the introduction of metal at an earlier period.

Considerable space is given to the My-

cenæan civilization which reached its zenith about 1500 B.C. It is pointed out that the dwellings of the period were not of a permanent character, while the houses of the dead were built for eternity. "The tombs with cupola of Greece and the giant dolmens of Denmark are derived from the same conceptions of life and death and are fundamentally one and the same thing. Nothing better than these monuments could reveal to us the unity of European civilization, and at the same time nothing shows more clearly the differences between the south and the north during the second millennium B.C."

Iron was known in Greece toward the close of the Mycenæan epoch, but was employed only for small objects. Bronze was the metal in general use. One could therefore speak of this epoch as the bronze age. But Müller prefers Mycenæan for Greece and bronze age for the rest of Europe, where the civilization was much less rich, though derived from the same source, *i. e.*, from the Orient through Greece. The typical weapon of the bronze age was the poniard. The sword came later, not before the close of the period. The fibula made its appearance here and was the point of departure for the development of feminine ornament during the epochs to follow, and after having fallen into disuse for ages has only recently appeared in its original form, but with another name—safety pin.

One remarkable prehistoric phenomenon is the plentitude and decorative richness of the bronze age in Scandinavia and the mediocrity of the same civilization in western Europe. The latter was received indirectly by way of Italy, while the former came directly by way of Orient. In all western Europe from Spain to Great Britain there is not found a single fibula of the bronze-age type. This absence joined with that of the spiral ornamentation is proof that the Occident was farther removed from Greek influences than were the Baltic countries. The Mycenæan culture is supposed to have reached the north by way of the Adriatic, western Hungary and Bavaria.

The lake dwellings form an interesting phase of the prehistoric in Europe. They are grouped about the Alps. Switzerland, southern Germany, Savoy, northern Italy and Austria (including Croatia and Hungary). The structures were quadrilateral, a fact suggesting Mycenæan influence. At least 200 village sites have been discovered in Switzerland alone since the winter of 1853–4. These belong to different epochs, the later neolithic, bronze and iron ages, respectively. Some in fact were inhabited during successive ages. The purely bronze-age stations are found farther in the water than are the purely neolithic.

Just as curious in their way as the lake dwellings are the terramaras of northern Italy. This is a corruption of "terramarna," a name which was given to the low flat hillocks in the valley of the Po from which a fertilizing earth has been extracted since early in the eighteenth century, long before the real significance of the deposits was known. They owed their existence to pile dwellings built on land but protected by water artificially regulated. Over a hundred have been explored thus far. The finest one is at Castione, northwest of Parma. Its present height above the plain is only three meters but the thickness of the deposit is five and a half meters. Three successive villages had stood on the spot, the first two having been destroyed by fire. The terramaras represent preeminently a bronze age culture that came from Greece by the way of southern Italy.

The Dipylon epoch in Greece witnessed the appearance of a special geometric style of decorative art, consisting of straight lines and meanders. This art, developed about 1000 B.C., was not original and spontaneous. Although it consisted of old elements, these were brought together to form a new and harmonious ensemble. The same motives were in use a thousand years later in Scandinavia. Figurines of the horse characterize this epoch. Gold and silver were scarce. The use of iron became general.

The Dipylon epoch gave Italy its first iron age, which in its turn became the point of departure for a new period of civilization in the other countries of Europe. This period in Etruria was characterized by cinerary urns of coarse paste, made without the use of the

wheel and with incised instead of painted ornaments. The motives, however, recall those of the Dipylon epoch in Greece—zigzags, meanders, etc. All sorts of small objects were placed with the dead—among others the bronze razor with a single edge in place of the earlier two-edged razor; also, a new type of fibula with highly arched body instead of the Mycenæan type. There appeared at this time a sword with a hilt terminated by two branches—a type destined to play an important rôle north of the Alps as far as Scandinavia.

The first iron age in Italy is generally called the first Villanova epoch (1000 B.C.). It is also called the epoch of well-shaped tombs, *tomba a pozzo*. The second epoch of Villanova reveals an increasing Greek influence accompanying a local original development. Incineration gave place by degrees to interment; and ancient linear ornament was succeeded by life forms repeated in series to form zones, recalling the Dipylon style. Much progress was shown in the construction of tombs, as witness the celebrated tomb of Regulini-Galassi discovered in 1836 at Cervetri. After the fall of Carthage, Greek influence practically superseded the oriental in Etruria. After having given to Tuscany its money, alphabet, architecture, industry and divinities, Hellenic civilization crossed the Apennines and invaded the Po Valley. The best evidence of this is afforded by the Certosa cemetery at Bologna.

The first iron age of central Europe had its sources in the recent Villanovan civilization of northern Italy. It is commonly called the Hallstatt epoch, from the village of Hallstatt in Austria near which was discovered a prehistoric cemetery representing the entire period. But the Hallstatt civilization was as restricted in area as it was distinctive in character. This limited zone became a center of civilization for the contiguous countries, which for the most part were still in the bronze age. This was particularly true of Hungary, Scandinavia and Switzerland.

The second iron age, or epoch of la Tène, dating from about 500 B.C., is better known than the Hallstatt epoch. We know that toward the close of the latter period there arose in what now corresponds to France and Germany a special civilization which reached its zenith during the fourth century B.C. There was created at the commencement of the period a decorative Celtic style of such value and refinement as to be considered not only original, but also national. Yet in the last analysis these motives are derived from the palmette and classic volute. The Celtic period may be divided into two epochs: an older corresponding to the Gallic domination and a younger represented by the discoveries at la Tène on Lake Neuchâtel. The two halves of the Celtic period were of unequal merit, the latter representing an epoch of decadence. The period left its traces in Scandinavia, some of the specimens being of excellent workmanship. In both Scandinavia and Great Britain the bronze age was prolonged into the epoch of la Tène.

The movement of civilization in western Europe during the epoch of la Tène had its counterpart in the region to the north of the Black Sea, where the cemeteries of the time have furnished such a surprising quantity of beautiful objects of art, particularly gold ornaments. This rich period may be placed between the fifth and the second centuries B.C. As one penetrates farther into the interior of Russia the indigenous Scythian art makes itself felt more and more. It is characterized by animal figurines or simply the heads of animals used ornamentally. A good part of Scythian art and industry came direct from Asia and eventually spread its influence over northern Russia and into Hungary.

Rarely has a victory had for the history of civilization such vast consequences as the victory of Alesia, 52 B.C., by which Cæsar vanquished the last armies of Gaul. After this the frontier of the prehistoric domain retreated rapidly toward the north. The Germanic world came into direct contact for the first time with the classic civilization of the south.

During the epoch of invasions there was a marked development of provincial industry. The Roman bronze vases, for example, were no longer made in the south for exportation,

but in the region of the Rhine and in France. The sixteen beautiful pails from the cemetery of Hemmoor near Hanover are examples. One often finds Roman motives in use, but under forms scarcely recognizable. Among the most remarkable specimens of this kind belonging to the epoch of invasions must be classed the celebrated golden horns of Gallehus in Schleswig. To this period also belongs the Roman silver service found at Hildesheim.

Differences are pointed out between the recent Celtic civilization of Germany and that of Great Britain and Ireland. At the time the Romans gained a foothold in England local Celtic art had reached a high stage of originality and development. Celtic elements were even borrowed by the Romans, whose political domination over the land did not exercise any marked influence on the national art, which continued without interruption particularly in Scotland and Ireland, and which culminated in the heroic and legendary Celtic period of the first 500 years A.D.

The last two chapters are devoted to the closing epochs of prehistoric times in Scandinavia (500 to 1000 A.D.), and to Finland and the Slavic countries.

Müller, who is director of the National Museum of Danish Antiquities, has been known for years as a gifted writer on northern archeology. The present volume maintains the high standard the author set for himself in earlier works. Each chapter is accompanied by a selected list of references. One misses, however, an index which is all but indispensable in a work so important as this. The next general work on prehistoric Europe will in all probability devote more space to the contributions of such men as Rutot and Penck; those of the former on pre-Chellean industry and those of the latter on the antiquity of man from the standpoint of glacial geology.

George Grant MacCurdy

Yale University

Grundriss der Kristallographie fur Studierende und zum Selbstunterricht. Von Dr. Gottlob Linck. Zweite umgearbeitete Auflage. Pp. 254, 604 figures, 3 colored plates. Jena, G. Fischer. 1908.

Since the appearance of the first edition of this little text-book of crystallography twelve years ago it has remained the most satisfactory elementary treatise on the subject in any language. Unlike most text-books in the same field, it discusses crystallography in all its phases. Crystals are treated as bodies possessing certain well-defined properties in consequence of their structure, rather than merely as bodies characterized by distinct forms.

Starting with a brief statement of the difference between typical fluids and typical solids, the author develops the usual conception with reference to the growth of crystals, and follows this with descriptions of different kinds of crystal aggregates, a discussion of the symmetry of crystal planes, and statements of their simplest zone relations. The 32 classes of crystal forms are then treated in detail in 92 pages. In the first edition this discussion occupied 116 pages. The reduction is due to the omission from the new edition of some unnecessary explanations of figures, to the condensation of such explanations as are retained, and to a slight rearrangement in the order of treatment of some features of the subject. Everything essential to the understanding of the principles of geometrical crystallography remains, and in addition there has been introduced a most excellent series of photographs of crystal forms and combinations that will prove a welcome novelty to the student. On the whole, the first half of the revised edition does not differ materially from the corresponding portion of the earlier edition.

It is in the last half of the volume in which the greatest changes are observed. This now occupies 114 pages as against 93 pages in the first edition. The study of the physical properties of crystallized substances has advanced so rapidly in the past decade, and the results of these studies have become of such practical importance in physical and chemical investigations that they merit much more careful consideration than is usually given them in text-books published in the English language. Indeed, there is scant reference to

this phase of crystallography in English and American text-books, and in those in which the subjects are treated at all the discussion is so poorly developed as to be practically valueless for teaching purposes.

While the elements of physical crystallography are merely touched upon in the volume under review, the development of the discussion is logical and connected, and at every step the correlation between physical and geometrical symmetry is emphasized.

The most notable advance made in this new edition, however, is in the chapter dealing with the relations between the physical properties of crystals and their chemical composition. This portion of the book now occupies 26 pages, whereas in the earlier edition it occupied only 11 pages. Morphotropism, homomorphism, isomorphism, eutropism, polymorphism and isopolymorphism are illustrated by tables of substances exhibiting these properties, and the terms are explained in sufficient detail to serve the purpose of introducing the student into the fascinating field of chemical crystallography.

In all respects the volume will serve as an excellent text-book in elementary courses in crystallography. It is more comprehensive than the usual text-book pretending to deal with the subject, as it covers the field in all its aspects. The student is shown that crystals are not merely bodies possessing characteristic forms, but that they are bodies which also possess characteristic physical properties, and that such a close relationship exists between their geometrical, their physical and their chemical properties that these characters must be regarded as being connected genetically. That crystallography is a rational science and not merely a descriptive one is the impression left by the reading of the book. It is an impression to be greatly desired of American students, who are too apt to look upon crystals from the geometrical standpoint only.

The objectionable feature of the book is its lack of references. While this omission may be argued as possibly on the whole desirable in most elementary science text-books, in a text-book on general crystallography the omission is extremely unfortunate. The literature of physical crystallography is so widely scattered that a guide to the most important articles in this branch of the subject would certainly be convenient to the user of the volume. To advanced students—and that is the class to which Dr. Linck's book will most appeal, in America at least—a guide is absolutely necessary if the study is to be followed with any seriousness. It is to be hoped that in the next edition the author will insert at least a few references which will indicate where the most important discussions in physical and chemical crystallography may be found.

W. S. Bayley

The Cell as the Unit of Life. By the late Allan Macfadyen, M.D., B.Sc. Edited by R. Tanner Hewlett, M.D., etc. Pp. 381 and biographical notice. London, J. and A. Churchill; Philadelphia, P. Blakiston's Son & Co. 1908. $3.00 net.

The lectures brought together in this volume were delivered by the late Dr. Allan Macfadyen at the Royal Institution, London, during the years 1899–1902, and have been edited and published by Professor Hewlett as offering "some memento of a life full of promise and cut off all too soon." The difficult task, undertaken *con amore*, has been well performed by the editor, and a very readable and acceptable, although from its very nature somewhat out-of-date, "introduction to biology" lies before us.

The work is divided into sections, the first of which, under the caption The Cell as the Unit of Life, consists of five lectures on rather elementary biology in which a captious critic might find abundant material to feed his flame; if a morphologist he would take exception to such slips as that which speaks of the "Polar Body or Centrosome" (p. 57), or if a protozoologist to false impressions given by statements such as that on page 79 to the effect that always in feeding, "the *Amœba* seeks out and selects the alga cell." The second section, under the heading Cellular Physiology, is misleading in that little or nothing is said about physiology of the cell, the lec-

tures being devoted almost exclusively to fermentation and the actions of enzymes external to the cell and not intra-cellular activities. The cytologist looks here in vain for information regarding constructive and destructive metabolism, oxidation, etc., in the cell. He finds, however, an excellent and clear exposition of the kinds of ferments and of their importance in digestion in animals and plants, and in the first lecture of this second set he finds a most excellent illustration of the cost in labor of ascertaining a single scientific fact, a concise history of the development during the last two hundred years of our knowledge of fermentation being given. The third section of three lectures entitled Recent Methods and Results in Biological Inquiry, and the last section of four lectures on Toxins and Antitoxins, contain much repetition of the earlier lectures, but we find here a valuable elaboration of the lines of research in a field where Dr. Macfadyen was familiar with every inch of the ground. Here is an excellent summary of the effects of microorganisms as agents of disease and of immunity to and prevention of disease, all as understood at the time the lectures were written and well serving as a basis for those who would study the modern developments of these important lines of biological research.

G. N. C.

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Experimental Zoology, Vol. VI., No. 2 (February, 1909), contains the following papers: "Studies on Chromosomes, V., The Chromosome-groups of Metapodius, A Contribution to the Hypothesis of the Genetic Continuity of the Chromosomes," by Edmund B. Wilson. This contains a detailed account of the "supernumerary chromosomes," which form a specific class and vary in number in different individuals of the same species. The facts are shown to form a strong support to the general theory of the genetic continuity of the chromosomes, of which a general discussion is given. "The Effects of Desiccation on the Rotifer, *Philodina roseola*," by Merkel Henry Jacobs. The old question of the possibility of revival of rotifers after a more or less protracted desiccation is again taken up, and as a result of numerous experiments the older view that recovery is possible after a true desiccation is confirmed and the newer one that the animal at the time of drying is protected by a water-proof cyst is shown to be based on insufficient evidence. In addition, it is shown that the process of drying serves as a stimulus to reproductive activity, a definite relation existing between the periods of drying and those of egg laying. "Protozoan Studies," by J. F. McClendon. Amœbæ do not respond to minutely localized mechanical stimulation unless this be repeated at short intervals of time. By chemical stimulation it was found that the stimulus traveled through the *Amœba* at a rate probably faster than the movement of the fastest ions in aqueous solution. The movement of this stimulus might be compared to the nervous impulse, save that not being confined to a nerve fiber it spreads in all directions. Experiments suggested the following hypothesis of food taking by the *Amœba:* External chemical and physical processes cause a hardening and shrinking of the surface protoplasm, thus forming the ectosarc. Internal processes cause a liquefying of the protoplasm, thus forming the endosarc. Unstable equilibrium between these two sets of processes causes amœboid movements. A protoplasmic food body near the *Amœba* protects it locally from external processes and thus causes the *Amœba* to bulge out toward the food. That spot on the *Amœba* that touches the food is stimulated, hardens and ceases to advance. Therefore lateral pseudopodia are formed and surround the food. Paramecia were centrifuged for periods of time up to one week. The nuclei, chromatin and other heavy substances were precipitated, but returned to their normal positions in about the length of time during which they had been centrifuged. The negative geotropism returned simultaneously with return of these substances. Centrifuging stimulated division. Centrifuging produced abnormalities and these were not transmitted to both products of binary fission. *Paramecium aurelia* formed membranous cysts and while in them often absorbed its own anterior or

posterior end. These were regenerated after liberation. The encysted Paramecia were killed by drying. From material obtained from a number of localities *Paramecium aurelia* was found to be dimorphic as regards size and the smallest specimens smaller than the smallest of *Paramecium caudatum.* "The Artificial Production and Development of One-eyed Monsters," by Charles R. Stockard. Salts of magnesium in solution are found to cause one-eyed monsters to develop from the eggs of the fish, *Fundulus heteroclitus.* These cyclopean individuals were produced in such numbers as to afford material for a full investigation of the processes involved in the formation of the defect.

BOTANICAL NOTES

VEGETATION PICTURES

SOME years ago Professors Karsten and Schenck, the former of the University of Bonn, and the latter of the Technical High School of Darmstadt, began the publication, through Gustav Fischer, of Jena, of a most interesting work under the title of "Vegetationsbilder." From time to time the successive parts have been noticed favorably in these columns, and now the reception of "Heften" 1 and 2 of the seventh volume calls for another notice. These are devoted to the vegetation of the volcanic regions of Java and Sumatra, and were prepared by Professor A. Ernst, of the University of Zurich, and the seventeen half-tone plates were made from photographs taken by him also. These plates are admirable examples of what may be done in the way of faithful reproduction, and make one wonder why it is so difficult, or perhaps even impossible, to secure work of this kind in this country at anything less than prohibitive prices. It is difficult to single out from these striking pictures those of greatest interest, but No. 5*a* showing pioneer vegetation on the volcano Merapi (2,981 meters), and No. 11*a* showing a grass steppe in the interior of the volcano Krakatau are especially noticeable. The text, of which there are twenty-four pages, is full and satisfactory. The excellence of the work, together with its very moderate price (2.50 Marks per heft) should make it one of the necessary works in every botanical library.

ANOTHER BOTANICAL JOURNAL

ON the first of January the well-known publisher, Gustav Fischer, of Jena, began the publication of a promising new monthly journal in the botanical field under the name *Zeitschrift für Botanik.* In size of page and number of pages for each number it resembles the *Botanical Gazette,* which in these respects was frankly taken by the projectors as the model for the new journal. The editors are Oltmanns, Solms-Laubach (who now withdrew from the *Botanische Zeitung*) and Jost, which fact is a guarantee of the high grade of the journal. This initial number consists of three parts, viz., (1) an original article of 86 pages; (2) reviews, covering 16 pages, and (3) a classified list of titles of new botanical books and papers. In the first paper there are 26 cuts, but this number contains no plates. The type and paper are good. The subscription price is fixed at 24 Marks. It will without doubt soon prove to be one of the most useful of the German botanical journals.

AMENDING THE VIENNA CODE

IN the February number of the *Bulletin of the Torrey Botanical Club* nineteen American botanists print eleven motions for amendments to the Vienna Code, and present arguments therefor. These motions are submitted "for the consideration of the International Botanical Congress to be held in Brussels in 1910." Briefly these motions cover the following points:

1 and 2. To apply these rules to fossil plants and non-vascular plants, which is not now done in the code. These appear to be desirable motions, and should be adopted.

3. To abolish the list of "Nomina conservanda," *i. e.,* names arbitrarily conserved contrary to the principle of priority. Here the contention of the committee is sound, and ultimately the code must be so amended as to conform to it, but whether this should be insisted upon at the present time admits of argument.

4 and 5. To change the rule requiring Latin diagnoses, to "Latin, French, English or German." The rule as adopted in Vienna is better, in our opinion, than the proposed modification.

6. To more clearly indicate valid and invalid naming of genera and higher groups. Here the committee's proposed amendments certainly make the rule more definite.

7. To provide for the disposition of the species when a genus is divided into two or more genera. Here again the committee's recommendation is much more specific than the rule in the code, and seems to provide for all the cases that may come up under it, which the original rule does not.

8. To provide for the proper retention of the original name in the division of a species. The committee's rule is much more specific and is a marked improvement upon the rule in the code.

9. To provide that priority of place upon the page shall be actual priority in the case of simultaneous publication of names. This is so reasonable that it should meet with no opposition.

10. To provide for the rejection of certain names by a more definite indication of the cases. The committee would reject "homonyms," "metonyms," "typonyms" and "hyponyms." Their statement is better than that of the code and may well be adopted by the congress.

11. To allow the specific name to be the same as the generic name, as in the familiar cases of *Taraxacum taraxacum, Linaria linaria,* etc. The Vienna Code requires the rejection of the specific name in such cases, in spite of the law of priority. The committee very properly regard this as "an unfortunate exception to the general law of priority."

On the whole it seems that this committee of American botanists is warranted in presenting its motions for amendments. With the exception of the fourth and fifth, relating to the diagnoses of new groups, we hope that these motions for amendments will be adopted.

Charles E. Bessey
The University of Nebraska

SPECIAL ARTICLES

A DISCUSSION OF SOME OF THE PRINCIPLES GOVERNING THE INTERPRETATION OF PRE-PERSOONIAN NAMES, AND THEIR BEARING ON THE SELECTION OF A STARTING-POINT FOR MYCOLOGICAL NOMENCLATURE[1]

If there is any one fact which more than others has become increasingly evident during the last thirty years in the study of fungi it is that a thorough examination of their microscopic characters is necessary for the certain determination of most of the species. The older systematists based their species entirely upon external characters. While the spores of fungi were early observed, they were regarded as of no importance systematically, and even as late as 1849 Fries himself forcibly stated that in the whole family of Discomycetes no natural genera could be based on carpological characters. In the decade between 1860 and 1870, however, influenced by the work of the Tulasne brothers and of de Bary, systematists turned their attention more seriously to the study of microscopic characters, and it at once became evident that important diagnostic marks were to be found in structures too small to be seen with the unaided eye. The great amount of careful morphological and developmental work which has been done among the fungi during the last thirty-five years has only emphasized the importance which should be attached to microscopic characters in distinguishing genera and species in this group. To such lengths has this tendency developed that in recent years whole systems of classification have been proposed based almost entirely on microscopic features, and in the eyes of all workers such characters have come to be regarded as the most important available bases for generic and specific distinction.

This method of study has frequently developed the fact that two or more plants, externally indistinguishable, really represented as many different species or even distinct genera. Illustrations of this condition are

[1] A paper read before the Botanical Society of America at its meeting in Baltimore, December 31, 1908.

very numerous among the Ascomycetes, and will at once occur to any one at all familiar with the fungi. A few concrete examples will perhaps put the matter in a more definite light. The genera and species of the Phycomycetes are based almost entirely on microscopic characters. Among the powdery mildews the genera *Sphærotheca* and *Erysiphe,* as well as *Podosphæra* and *Microsphæra,* can not be distinguished from each other without the use of the microscope. Most of the genera and species of the Pyrenomycetes are founded on characters drawn from the asci and spores, which can not be made out with the unaided eye. Among the Discomycetes the genus *Trichoglossum* is represented in America by about half a dozen species which are indistinguishable by their gross features. The genera *Geoglossum* and *Corynetes* can not be told apart by external characters. The same is true of *Barlæa* and *Humaria, Sphærospora* and *Lachnea,* and many others. In nearly all of these genera are whole groups of well marked species which are based entirely on minute microscopic characters. Specific limits among the rusts, smuts and other groups are too familiar to need mention. On the other hand, it is equally true that there are certain fungi which are so unique and well marked that they stand off by themselves, and can be much more certainly recognized by external features alone. Such species occur more commonly among the larger fleshy and woody forms, but even here minute hymenial characters are recognized as being of the greatest systematic importance. No one can venture to assert that careful students of these better marked forms may not soon discover microscopic features at present unused which may entirely upset our ideas of their specific limits. It is not necessary to dwell further on this phase of the subject, for the facts are too familiar to need elaboration. Enough has been pointed out to emphasize the fact that the number of species of fungi which may be placed with certainty on the basis of external characters alone is comparatively small.

If, therefore, the accurate determination of most of the species of fungi on the basis of gross characters alone is next to impossible when the living plant is actually before one, how much more uncertain must be the identification of the species of older writers, which are represented by only brief descriptions of the most obvious external features, or at best by figures often crudely drawn or inaccurately colored. The simple fact is that the majority of the species of fungi described by writers before 1800 can not be recognized with certainty at the present time, when measured according to present-day standards. Yet systematic literature is filled with the references of well known fungi to names dating from Linnæus, Scopoli, Jacquin, Batsch, Bulliard, Paulet, Schaeffer, Adanson, Schrader and many others, the majority of which are at best involved in doubt. Of course it is perfectly possible for one to speculate on the probabilities in such cases, but positive conclusions can never be inferred from doubtful premises, and he will be no nearer definite knowledge at the end of his speculations. The writer firmly believes that in the field of systematic mycology a single gram of knowledge is of more value than kilos of guess-work, supposition and uncertainty, and he wishes here to raise the question and to invite discussion as to whether the time has not come to take steps to eliminate from consideration these old names, the great majority of which can never be definitely fixed.

We are thus led naturally to inquire Why should mycological nomenclature date from Linnæus's "Species Plantarum" of 1753, and thus include this mass of undeterminable names? While Linnæus had a good understanding of vascular plants the distinguishing characters of which are gross and external, his knowledge of the lower organisms, especially of algæ and fungi, was very slight. Indeed, it seems probable that very little that he wrote concerning the fungi was based on his own first-hand knowledge, but that his work with these plants consisted principally in the application of binomial designations and brief descriptions to those figured by his predecessors. The distinguished botanists of Harvard University have stated the matter so admirably that I can do no better than to quote from them as follows:

Although the year 1753 seems eminently desirable as the starting point for the nomenclature of the spermatophytes, the use of this date among the lower groups, as for instance the algæ, appears not only highly inexpedient but well-nigh farcical. Among the flowering plants both genera and species had by 1753 been interpreted with a tolerable degree of definiteness, and their descriptions were at that time drawn with sufficient understanding of morphological and diagnostic features to make them in general intelligible to future generations. On the other hand, at the date of Linnæus's "Species Plantarum" the knowledge of the algæ was far too crude to form a satisfactory basis for their classification or nomenclature. Even the optical appliances necessary for the intelligent examination of this group had not been invented. What is here said of the algæ is quite as true of the fungi and applies in lesser degree even to the bryophytes and pteridophytes. Furthermore, the great difficulty or impossibility of preserving specimens in several of the lower groups, and the consequent fact that no type specimens are now extant for a large proportion of the species of the lower orders, render it all the more imperative that the beginning of nomenclature in these groups should not be carried back to a time of brief, vague and unintelligent descriptions.

In consideration of these facts it seems desirable that in the nomenclature of the spermatophytes priority should be reckoned from the publication of Linnæus's "Species Plantarum" in 1753, but in the case of all other groups, from a date near 1800, to be more exactly determined by a committee of specialists in cryptogamic botany, appointed by the International Congress in whatever manner it may seem best.[2]

Acting with a knowledge of the facts so comprehensively stated in the quotation just given certain algologists are advocating the selection of much more recent dates as the points of departure for the nomenclature of certain groups. Why should not students of the fungi do the same; and, if any such action is to be taken, what is the most desirable date to be selected? The writer has seen only a single definite proposition bearing on the selection of such a starting-point, and ventures to offer the following suggestions in the hope that they may stimulate discussion of the matter.

[2] "Amendments to the Paris Code of Botanical Nomenclature," p. 13, 1904.

It may be well to point out at once some of the considerations which should have weight in the selection of a starting-point for mycological nomenclature. In the first place there should be, if possible, a common point of departure for all groups of fungi. Secondly, the date selected should be early enough to include the greatest possible number of published names. Thirdly, it should, if possible, mark the beginning of some important epoch in mycological history. Fourthly, the personage whose work is chosen should be one of the most prominent in the development of systematic mycology. Fifthly, the specific work selected should be a comprehensive one which deals with all the principal groups, which summarizes what has been done before, and which, in a word, bears about the same relation to the classification of fungi that Linnæus's "Species Plantarum" does to that of the vascular plants. Sixthly, and perhaps most important, it should be the work of a person who preserved a considerable proportion of the specimens on which his publications were based, and whose collection is now available for examination, so that his names can be fixed with some degree of definiteness.

It would be too much to expect that any one work should be in all respects ideal, and it would be impossible to select one which would not be open to some objection, but the one which in the opinion of the writer comes the nearest to fulfilling all the requirements named above is Persoon's "Synopsis Methodica Fungorum," published in 1801.

A brief historical sketch will make clearer the reasons for this opinion. The development of systematic mycology covers three quite distinct periods, each of which is marked by its own peculiar point of view and characteristic method of work. These may be designated as (1) the pre-Persoonian period or period of the illustrators, (2) the Persoon-Friesian period or period of the systematists, and (3) the modern period or period of the morphologists. The first period covers approximately the last three quarters of the eighteenth century, extending from about 1725 to about 1800, and as characteristic may

be cited the work done by Vaillant, Micheli, Schmidel, Schaeffer, Batsch, Holmskjold, Bulliard, Paulet and Sowerby. These men were all essentially illustrators. In their publications the larger and more conspicuous fungi were figured with some care and usually in color. Their plates were accompanied by descriptive text which, of course, dealt only with the gross and external features of the plants discussed. In most cases names were applied to the plants illustrated. Before the time of Linnæus these were mostly descriptive polynomials, but later the binomial method of designation was employed. Although the illustrators came to group their species in several genera on the basis of the most obvious superficial resemblances, no attempts were made by any of them to perfect a systematic arrangement of the fungi which could be at all compared with those which had been worked out for the flowering plants during the same time. In only a few instances have any of the fungi illustrated in this period been preserved so that aside from the information conveyed by the descriptions and figures we have no means of determining what plants the authors had before them. The writer has already attempted to show that the majority of the species of fungi described in this period can not be recognized with certainty at the present time, when measured according to present-day standards. The information about fungi in this period was in a much more crude and unsystematized state than that which prevailed concerning the spermatophytes before the time of Linnæus. It is primarily of historical rather than scientific interest, and consequently can be left out of consideration without any resulting serious loss to scientific knowledge. Surely no logical starting-point for mycological nomenclature can be found in this archaic period.

The second period of mycological history covers approximately the first two thirds of the nineteenth century, extending from 1800 to about 1865. With the advent of Persoon a complete change came over the aspect of mycological study. The attention of workers was turned from the illustration of fungi to their classification and systematic arrangement. The work of this strange man in his garret at Paris either directly or indirectly profoundly influenced that of such students as Wahlenberg, Fries, Schumacher, Nees von Esenbeck, Corda, Ditmar, Rabenhorst, Schweinitz, Duby, Desmazières, Leveillé, Montagne, de Notaris, Berkeley, Broome and many others who came after him, and whose names are familiar as household words to the mycologist. As the result of their labors immense numbers of new species were brought to light, their external features described, and arranged according to the then approved systems of classification. This method of work characterized the second or Persoon-Friesian period of mycological development.

While Persoon's publications before 1800 were of minor extent, yet they introduced an entirely new point of view. Persoon really originated systematic mycology. The "Synopsis Methodica Fungorum," of 1801, is one of the few epoch-making mycological publications. Not only was it the pioneer work of its kind, but it became the direct foundation of the Friesian system of arrangement which remained in almost universal use for half a century. While the Persoon-Friesian methods of classification are not those in use to-day, they were probably the best which the existing knowledge of fungi permitted, and they undoubtedly served their purpose fully as well as did the Linnæan system among the seed-plants.

Persoon's "Synopsis" was a comprehensive work in that all the groups of fungi known at the time were treated. It was synoptical in that its author went over the works of his predecessors, brought together the scattered descriptions, and either incorporated the names directly or arranged them as synonyms as seemed to him warranted by the evidence at his command. The "Synopsis Methodica Fungorum" therefore bears about the same relation to the systematic arrangement of the fungi that Linnæus's "Species Plantarum" does to that of the spermatophytes. The same reasons which led to the adoption of the latter as the starting-point for the nomenclature of the higher plants should cause Persoon's work to be chosen for that of the fungi.

While it is true that Persoon, and nearly all the students of fungi in this period, studied only external characters, it is equally true that Persoon and Fries and the majority of the workers of their time *preserved a considerable number of their fungi,* and their collections are now available for study. The result is that a majority of the names from Persoon down can be fixed with a degree of definiteness which is impossible for those described before his time. Objection may be raised that many of Persoon's types are missing from his herbarium; that herbarium specimens are liable to become interchanged, and that in other cases it is often difficult or impossible to determine just what his type of a particular species was. There is undoubtedly force in this argument, but it must be admitted that specimens, although sometimes confused, are the most reliable bases for determination that we have, and the same objections may be brought against any other collection, even against some of those of quite recent date.

Some mycologists, perhaps, might be willing to begin their nomenclature with Persoon, but would urge that his more mature and elaborate work, the "Mycologia Europæa," should be chosen as the starting-point. To the mind of the writer the principal objections to starting with this later work are: (1) That its publication extended over several years, from 1822 to 1828; (2) that it was almost exactly contemporaneous with another equally, if not more important work, the "Systema Mycologicum" of Fries; (3) it, therefore, does not stand out in a class by itself at the beginning of an epoch.

It has been suggested by certain students of fungi that the "Systema Mycologicum" of Fries should be used as the starting-point for mycological nomenclature. While the writer recognizes fully that this work is one of the most important and influential systematic mycological contributions yet produced, and that scientifically it was a great advance upon the "Synopsis Methodica Fungorum" of Persoon, yet he believes that no lack of appreciation of its value is shown in the conviction that it is not so natural a starting-point for nomenclature as is Persoon's work. The following reasons may be given in support of this opinion: (1) The publication of the "Systema" extended over several years from 1821 to 1832, a long period of time which would, in fact, establish different starting-points for the various groups of fungi. (2) In the year of publication of each of the earlier parts appeared important works by other authors (*e. g.,* S. F. Gray, 1821; Persoon, 1822; Schweinitz, 1822; Greville, 1823), in which cases it would be difficult if not impossible to determine priority of publication. (3) It, therefore, does not stand out in a class by itself at the beginning of an epoch, but is one of a number of publications on the same subject which appeared about the same time. (4) While Fries's system of classification was much more elaborate than that of Persoon, and showed a better understanding of relationships and of the relative value of characters, it was in many, if not most, of the groups founded directly upon that in Persoon's "Synopsis."[3] (5) Fries's species are no more capable of positive identification at the present time than are those of Persoon.

The third period in the development of mycology began in the decade between 1860 and 1870, when the second and most important change came over the aspect of the study of fungi. This movement was inaugurated by the publication of the Tulasnes' "Selecta Fungorum Carpologia" (1861–1865) and of de Bary's "Morphologie und Physiologie der Pilze, Flechten und Myxomyceten" (1866). Most of the work done before this time had consisted in the almost interminable species-making on the basis of the external and gross features of the plants examined, but from this time on the attention of students was directed to the study of the morphological details and the development of fungi, a kind of investigation which has laid the foundation for sounder systems of classification. In some respects it would be better to start the nomenclature of fungi with some important work in which the

[3] For a concrete example see the present author's analysis of the relation of Fries's classification of the fleshy discomycetes to that of Persoon in *Bull. Torr. Bot. Club,* 27: 464–466, 1900.

more modern ideas of classification are made use of. There is, however, no great epoch-making work in this period which is adapted to being made such a starting-point, and, moreover, the selection of such a late date would exclude a very large proportion of the known genera and species of fungi, which had been described before the period began.

The question will naturally arise in the minds of some Why, after all, is it necessary to fix a special date for the beginning of nomenclature of the fungi? It is manifestly impossible to adopt any starting-point which will effectually remove from consideration all the vague and uncertain names. Why not leave the matter open? Let monographers trace the history of each species and adopt the earliest name which can with certainty be applied to it, and relegate the uncertain names to the limbo of species ignotæ. One may reply to such objections that the whole matter is one of expediency; that while many of the names published after 1801 must always remain undeterminable on account of the absence of authentic specimens, the majority can be definitely identified because the describers preserved the specimens on which the names were based; that while some of the names published before 1801 were applied to plants so unique that they can be placed with reasonable certainty without specimens, the majority can never be accurately, or even approximately, determined for the reasons already pointed out; that as long as the way remains open attempts will be made continually (as has been done in the past) to revive these archaic names on the basis of supposition and a discussion of the probabilities in each case, a kind of reasoning which can never lead to definite conclusions, but which must always be productive of uncertainty and difference of opinion, with a consequent continued unsettled condition of the nomenclature of even the commonest fungi. For these reasons the writer believes that a special starting-point should be adopted so that a large proportion of these vague, indefinite, unintelligently characterized names which can never be definitely fixed should be effectually disposed of.

The writer would, therefore, urge the adoption of Persoon's "Synopsis Methodica Fungorum," of 1801, as the starting-point for mycological nomenclature for the following reasons:

1. The names applied to fungi before the time of Persoon should be excluded from consideration for the reason that the majority of them can never be definitely and certainly identified.

2. Any publication in the modern period is too recent and exclusive, a large proportion of the systematic work with fungi having been done before it began.

3. Its date of publication is early enough to include a great majority of the published names of fungi, and nearly all of those which can be certainly fixed at the present time.

4. Its publication marks the beginning of the second important epoch in mycological history, that of the scientific study of fungi.

5. It is the first important systematic work of the founder of systematic mycology, and is therefore the logical point with which to begin the nomenclature of the subject.

6. It is a comprehensive work which can be used as well as any other as the common point of departure for all groups of fungi.

7. It is a synoptical work which summarizes what had been done before its time, so that it bears about the same relation to the classification of fungi that the "Species Plantarum" of Linnæus does to that of the seed-plants.

8. Persoon's herbarium is in existence and is available for study, so that a considerable proportion of his names can be fixed with a degree of definiteness which is impossible for those published before his time.

9. It possesses an advantage over the "Systema Mycologicum" of Fries in that it was published within the limits of a single year in which no other important work on mycology appeared, so that it stands alone in a class by itself at the beginning of an epoch.

10. The adoption of this date would remove the incentive for much guess-work and speculation on the probable identity of many of the vaguely and unintelligently described or crudely figured species of fungi, which must always remain incapable of certain identifica-

tion, and would thus contribute materially to the stability of mycological nomenclature.

Elias J. Durand

Botanical Department,
Cornell University

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 456th meeting was held March 6, 1909, with President Palmer in the chair. Dr. Theodore Gill offered some notes on oral gestation in cichlid fishes. He said that there was much to learn about the habits of American cichlids and especially about their buccal incubation. Professor Putnam as long ago as 1863, in the *Proceedings* of the Boston Society of Natural History (p. 226), remarked that "in the genus *Bagrus* [really *Arius*] Professor Wyman found that it was the male that took charge of the eggs, while in the Chromoids [*i. e.*, Cichlids] it is the female. The specimens in which this peculiar fact was noticed were presented to the Museum of Comparative Zoology by Rev. J. C. Fletcher, from the Rio Negro, and by Professor Wyman, from Surinam. In these specimens the eggs and young were found in all stages of development."

This statement has been universally overlooked and various authors, especially Lortet and Günther, maintained that it was the male that took charge of the eggs, and not till 1902 and later did Boulenger and Pellegrin demonstrate that it was always the female of Syrian and African cichlids that did so. There was much uncertainty about the American species and the genus comprising the "two species" observed by Putnam was not named. It was probably *Geophagus*.

Very recently, in an article on the "Freshwater Fishes of French Guiana" extracted from the *Revue Coloniale*, Dr. Pellegrin claimed that it was the male of the American *Geophagi* that nurses the eggs; his words are "Chez les Géophages américains c'est le mâle qui se charge ainsi des soins à donner aux œufs et aux jeunes; chez les Cichlides africains comme les Tilapies, c'est la femelle ainsi que M. Boulenger et moi l'avons montré."

It is improbable that the American species differ so decidedly from the African and the neglected half-century-old observations of Wyman and Putnam deserve resurrection. Perhaps the specimens observed are still in the Museum of Comparative Zoology and can be identified by Mr. Garman or Professor Eigenmann. Agassiz in his "Journey to Brazil" in 1865 made some observations but did not state whether the egg-carrying individuals were females or males.

Now that much attention is being paid to the breeding habits of fishes, we may hope that definite observations will soon be made of American cichlids. Some, indeed, have been published by German aquarists which appear to show that there may be considerable difference in the habits of the species, but the information is still unsatisfactory. May this note serve to elicit more definite data.

Dr. L. O. Howard referred to the importation of the brown tail moth accompanying seedlings from France. It is a practise of American nurserymen to buy seedlings from the north of France. Thirty per cent. of a recent shipment carried the winter nests of the moth. There is no national inspection law in this country and the stock had become widely distributed before its infection was known. Much of it was later traced and destroyed under state laws. An old federal law forbids the carrying of such infected stock in vessels, and steamship companies after a warning are now more careful in this respect. A protest from the French nurserymen alleged that the brown tail moth would not thrive in our northern states, and was already common in the southern states. But the fact is that in this country the moth is a great pest in the northern states to which it is confined.

The chair referred to the reservation by executive proclamation under the Monuments Act of several regions containing objects of scientific interest. The recent creation by President Roosevelt of the Mt. Olympus National Monument in the Olympic Mountains of Washington, the home of the Roosevelt elk, is the first of its kind having a zoological as well as geological interest.

Dr. Evermann called attention to a recent act of Congress which provides for the establishment of a biological station at Fairport, Iowa. An appropriation of $25,000 for the establishment of this station was made a year ago and recently Congress passed the item providing for the personnel. The site has been definitely selected at Fairport, Iowa, where the bureau has acquired sixty acres of land admirably suited to the purpose. About fifty acres of the land lies along the river front and is exceedingly well adapted to the construction of the necessary ponds, of which there will be several acres. Near the river front is a railroad used by two companies with a number of trains each way daily, thus affording adequate railroad facilities. Some 1,800 feet from the river front is a public highway connecting

Muscatine and Davenport. Just above the highway the ground rises into a low bluff near the base of which are beautiful locations for the director's residence and such other residences as may be required. The laboratory proper will doubtless be located on the lower land just below the public highway.

It is the intention of the Bureau of Fisheries to make this in every respect a well equipped biological laboratory where any and all problems concerning the aquatic life of the streams and lakes of the upper Mississippi Valley may be studied. The primary and most important purpose of the station will be the carrying on of experiments and actual culture in connection with the artificial propagation of the Unionidæ or fresh-water mussels. The shells of various species of fresh-water mussels are now being used extensively in the manufacture of pearl buttons. The industry centers at Muscatine and Davenport, between which two cities the biological station will be located. The business now utilizes more than 50,000 tons of these shells and produces an output of $6,000,000 worth of buttons and by-products annually. Naturally this heavy drain upon the supply of shells will soon lead to the depletion of the beds unless something can be done toward the artificial propagation of the species. Drs. Lefevre and Curtis, of the University of Missouri, have fortunately developed, purely through scientific investigation, methods by which several of the species can be propagated very successfully, and it is the intention to carry on mussel-cultural work of this kind very extensively at the Fairport station.

In addition, however, to the mussel-cultural work, it is the intention to equip this laboratory in such a way as to furnish adequate facilities for the study of the various species of fishes and other aquatic animals and aquatic plants of the upper Mississippi basin, and it is believed that this will appeal to the biologist of that region as well as of the entire country.

The personnel provided consists of (*a*) director, (*b*) superintendent of fish-culture, (*c*) two scientific assistants, (*d*) one shell expert, (*e*) one engineer, (*f*) two firemen and (*g*) two laborers. Construction work on the station will begin early in July and it is hoped that the station may be ready for work by November.

The following communications were presented:

Chickens without Feathers: R. H. Chapman.

Illustrations were shown of fowls that had failed in normal feather development. The birds were observed at Delhi, N. Y., during the summer of 1908. About 500 chicks of the barred Plymouth Rock variety were incubator hatched during June. They were all apparently normal for a short time, but about ten per cent. failed to grow the usual covering. The photographs shown were taken in November and the birds were about four months old, and included the fully feathered as well as naked birds. The death rate among the freaks was high, though some of them lived until the cold weather set in. The only clew to an explanation given was the fact that the parents of the chicks had been persistently inbred for some four years. The phenomenon has been previously observed at farms in Virginia but never in such a large proportion of the hatching.

Résumé of a Study of the Madreporaria of the Hawaiian Islands: T. Wayland Vaughan.

The Recent Crinoids and their Relation to Sea and Land: A. H. Clark.

The speaker discussed the distribution, ecology and coloration of the recent crinoids, following closely his paper on the subject published in the *Geographical Journal* (London) for December, 1908; he said further that the predominating purple or violet in the littoral species may be a factor of great importance in their economy, for many of the small organisms upon which they feed are strongly attracted by the violet rays of the spectrum, and hence would tend to swim toward a purple or violet crinoid, placing the latter in the economically advantageous attitude of attracting to itself, instead of having to pursue its food. *Uintacrinus* was cited as an instance of a purely pelagic derivative from the common comatulid stock; in life it probably floated with its globular body upward and its arms dependent downward, just like the similarly built jelly-fish of recent seas; it lived in great masses, as do many recent medusæ, and this was probably an advantage, for these masses would shade the water immediately beneath them, and many of the small lucifugous organisms would take refuge in this shade, only to be picked up and eaten by the *Uintacrinus*. The occurrence of crinoids in large masses of individuals all of which are of approximately the same size was explained by the inability of the young of the mass to obtain a food supply when shaded by the arms of the adults; hence the young can not survive unless drifted to some distance from the parents.

The 457th meeting was held March 20, 1909, with President Palmer in the chair. The program consisted of an illustrated discussion of "Camp-

ing and Camp Outfits," by A. S. Hitchcock, V. Bailey, H. S. Barber, W. H. Osgood, J. W. Gidley and E. A. Preble. Articles of camp equipment were exhibited, methods of carrying packs demonstrated, and many lantern slides shown.

M. C. Marsh,
Recording Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 663d meeting was held March 27, 1909, Vice-president Wead in the chair. Two papers were read.

The Present Status of Wireless Telegraphy and Telephony: Dr. L. W. Austin, of the Bureau of Standards.

Two years ago there were four principal practical problems before the workers in radiotelegraphy:

1. Doing away with the irregularities of the atmospheric absorption of the signals which caused waves of the same intensity to be at one time detected at a distance of 1,000 miles, at another not over 100.

2. The elimination of the disturbances in the receiving station due to atmospheric discharges which frequently made the reception of signals entirely impossible.

3. The production of directed signals capable of commercial use.

4. The production of electrical oscillations suitable for wireless telephony.

The first of these problems has been successfully attacked by Professor Fessenden, who has shown that by using a wave-length of approximately 4,000 meters the absorption is much reduced and becomes practically constant under all conditions both by day and night.

The second problem is still not satisfactorily solved, although the conditions are much improved by sharper tuning of the receiving circuits and especially by the use of a loose coupling of the receiver.

In regard to the third problem, a certain amount of success has attended the experiments of Marconi, who by using a bent antenna has succeeded in giving direction to the electrical waves. Bellini and Tossi in France have also obtained very satisfactory results by the use of a kind of loop antenna.

In wireless telephony, continuous trains of oscillations produced either by the arc or by means of high-frequency dynamos have been so far improved that the range of working has been increased from about 10 miles to over 200.

A Calorimeter for the Determination of the Specific Heat of Liquids: Mr. H. C. Dickinson, of the Bureau of Standards.

A Dewar flask of the ordinary spherical form, of five liters' capacity, has been adapted for use directly as a calorimeter for measuring the specific heat of liquids. The particular problem attacked has been the measurement of the specific heat of calcium chloride solutions at low temperatures. For this purpose the flask is immersed in a mixture of ice and water and filled with the solution to be tested, cooled to the lowest temperature its concentration will permit.

The method consists in accurate measurements of the temperature of the weighed contents of the flask, alternating with short periods during which energy is supplied electrically to raise the temperature of the liquid. The temperature is raised by steps of about 5° C. and the energy supplied, and the corresponding rises of temperature are measured for each 5° interval. Such a series of observations with a single sample of solution, occupying about one and a half hours, gives a specific heat for intervals of 5°, between —30° C. and +20° C.

The water equivalent and radiation constant for the calorimeter were determined with great care by a separate series of experiments, using pure water. The water equivalent of the calorimeter, stirrer, thermometer, etc., is only about 2 per cent. of the total water equivalent of the solution used.

The total correction for radiation with a temperature difference of 30°, amounts to only about two per cent. of the energy supplied.

The energy, supplied electrically, is measured to about 2 parts in 10,000 by means of a potentiometer in connection with a standard 0.1-ohm shunt and a volt box.

Temperature differences are measured by means of a resistance thermometer having a sensibility of about 0°.0005 C.

The time intervals necessary in computing the total energy are measured by means of a tape chronograph to about 0.02 second.

The following table gives the values found for the specific heat of solutions of chemically pure calcium chloride and water of different densities, where t is the temperature in degrees C.:

Density	Specific Heat	Temperature
1.07	$0.869 + 0.00057\,t$	(—5° to +15°)
1.14	$0.773 + 0.00064\,t$	(—10° to +20°)
1.20	$0.710 + 0.00064\,t$	(—20° to +20°)
1.26	$0.662 + 0.00064\,t$	(—25° to +20°)

R. L. Faris,
Secretary